6 - 8 December

Melbourne, Australia

PROCEEDINGS

of the International Conferences

INTERNET TECHNOLOGIES & SOCIETY 2016

Edited by:
Piet Kommers
Tomayess Issa
Theodora Issa
Elspeth McKay
Pedro Isaías

ICEDUTECH

educational technologies 2016

STE 2016

SUSTAINABILITY, TECHNOLOGY AND EDUCATION

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international association for development of the information society

INTERNATIONAL CONFERENCES ON

INTERNET TECHNOLOGIES & SOCIETY 2016 (ITS 2016)

EDUCATIONAL TECHNOLOGIES 2016 (ICEduTech 2016)

AND

SUSTAINABILITY, TECHNOLOGY AND EDUCATION 2016 (STE 2016)

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MELBOURNE, AUSTRALIA

6 - 8 DECEMBER, 2016

Organised by

IADIS
International Association for Development of the Information Society

Co-Organised by

RMIT UNIVERSITY

Edited by Piet Kommers, Tomayess Issa, Theodora Issa,
Elspeth McKay and Pedro Isaías

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FOREWORD

These proceedings contain the papers and posters of the International Conferences on Internet Technologies & Society (ITS 2016), Educational Technologies (ICEduTech 2016) and Sustainability, Technology and Education (STE 2016), which have been organised by the International Association for Development of the Information Society and co-organised by the RMIT University, in Melbourne, Australia, 6 - 8 December 2016.

The Internet Technologies & Society conference aims to address the main issues of concern within WWW/Internet as well as to assess the influence of Internet in the Information Society.

Broad areas of interest are Internet Technologies, Information Management, e-Society and Digital Divide, e-Business / e-Commerce, e-Learning, New Media and e-Society, Digital Services in e-Society, e-Government / e-Governance and e-Health. These broad areas are divided into more detailed areas (see below). However innovative contributes that did not fit into these areas were also considered since they are of benefit to conference attendees:

- Internet Technologies: Electronic Data Interchange (EDI), Intelligent Agents, Intelligent Systems, IS Security Issues, Mobile Applications, Multimedia Applications, e-Payment Systems, Protocols and Standards, Semantic Web and XML, Services, Architectures and Web Development, Software Requirements and Web Architectures, Storage Issues, Strategies and Tendencies, System Architectures, Telework Technologies, Ubiquitous Computing, Virtual Reality, Web 2.0 Technologies, Social Networking and Marketing and Wireless Communications.
- Information Management: Computer-Mediated Communication, Content Development, Cyber Law and Intellectual Property, Data Mining, e-Publishing and Digital Libraries, Human Computer Interaction and Usability, Information Search and Retrieval, Knowledge Management, Policy Issues, Privacy Issues, Social and Organizational Aspects, Virtual Communities, Internet and Disability, Internet and Aging Population, e-Society and Digital Divide, Social Integration, Social Bookmarking, Social Software, e-Democracy and Social Integration.
- e-Society and Digital Divide: Social Integration, Social Bookmarking, Social Software, e-Democracy and Social Integration.
- e-Business / e-Commerce: Business Ontologies and Models, Digital Goods and Services, e-Business Models, e-Commerce Application Fields, e-Commerce Economics, e-Commerce Services, Electronic Service Delivery, e-Marketing, Languages for Describing Goods and Services, Online Auctions and Technologies, Virtual Organisations and Teleworking.
- e-Learning: Collaborative Learning, e-Mobile Learning , Curriculum Content Design & Development, Delivery Systems and Environments, Educational Systems Design, e-Citizenship and Inclusion, e-Learning Organisational Issues, Evaluation and Assessment, Political and Social Aspects, Virtual Learning Environments and Issues and Web-based Learning Communities.

- New Media and e-Society: Digitization, Heterogeneity and Convergence, Interactivity and Virtuality, Citizenship, Regulation and Heterarchy, Innovation, identity and the global village syndrome, Internet Cultures and new interpretations of "Space" and Polity and the Digitally Suppressed.
- Digital Services in e-Society: Service Broadcasting, Political Reporting, Development of Digital Services, Freedom of Expression, e-Journalism and Open Access.
- e-Government /e-Governance: Accessibility, Democracy and the Citizen, Digital Economies, Digital Regions, e-Administration, e-Government Management, e-Procurement, e-Supply Chain, Global Trends, National and International Economies and Social Inclusion.
- e-Health: Data Security Issues, e-Health Policy and Practice, e-Healthcare Strategies and Provision, Legal Issues, Medical Research Ethics and Patient Privacy and Confidentiality.

The International Conference on Educational Technologies (ICEduTech) is the scientific conference addressing the real topics as seen by teachers, students, parents and school leaders. Scientists, professionals and institutional leaders are invited to be informed by experts, sharpen the understanding what education needs and how to achieve it.

Topics for the ICEduTech Conference:

- Education in Context: Education in the Network Society, Educational Games, Social Media in Education, Home Schooling, Students' Rights, Parents' Rights, Teachers' Rights, Student-Safe Searching, School Violence, Education and Tolerance for Peace and Education in Developing Countries.
- Education as Professional Field: Teacher Education, Teachers' Professional Development, Teachers' Workload, Teacher Support for Grading, Time Tabling, Grading, Learning Tools, and Online Learning Software, Teachers' Learning in Communities of Practice, Web-based Communities for Teacher Support, Teachers' Career Planning, Legal and Financial Issues, Conflict Resolution and Mediation, Governance and Servant Leadership and Educational Policies.
- Curricular Evolution: Problem-based Learning, Critical Thinking Skills, Creativity Skills, Learning Citizenship, Global Education, Media Literacy / Pedagogy, Multicultural Education and Alternative Assessment Methods.
- Learner Orientation: Student-Oriented Learning, Peer- and Collaborative Learning, Learning Strategies: Learn how to Learn, Motivating Students, Recognizing Students' Learning Styles and Special Education.
- Integrating Educational Technologies: Social Media and Social Networking, The Semantic Web 3.0, Podcasting for Broadcasting Video Lectures, Podcasting feedback to students, Wiki and blogs in Higher Education, Mobile, Virtual and Vicarious Learning and Simulations and Modeling.
- International Higher Education: Marketing Higher Education as a Business Case, Pitfalls and Solutions in Joint and Double Degree Programs, Enculturation and International Teacher Accreditation, Web-based, Mobile, Virtual Presence and

Social Media to Overcome Student Mobility, Blended Learning and Student Assessment at a Distance, Student Mobility and Distance Education, New-Emerging Standards and Benchmarks for Higher Education, Education, Research, Exchange an Capacity Building, 21st Century Academic and Industrial Brain Exchange, Academic Salaries, Faculty Contracts, Residence Permits and Legal Issues, International Student Exchange Funding Programs: Erasmus Mundus, the U.S. Council on International Educational Student Exchange, and the Euro-American "Atlantis" program, Networks for International Higher Education in the Pacific, Australia, Europe, Asian and European countries and Higher Education, Cultural Diversity, Tolerance and Political Conflict.

The International Conference on Sustainability, Technology and Education (STE) aims to address the main issues which occur by assessing the relationship between Sustainability, Education and Technology.

Broad areas of interest are: Sustainability and Leadership, Sustainability and Green IT, Sustainability and Education. These broad areas are divided into more detailed areas (see below).

- Sustainability and Leadership: Sustainability and Management, Corporate Social Responsibility and Sustainable Design, Sustainable Design and Business Strategy, Sustainability and Accounting, Sustainability and Finance and Economic, Sustainability and Marketing and Barding, Technology Development and Innovation at Small and Medium-Sized Enterprises, Sustainability and Natural Resources, Sustainability and Sustainable Design, Sustainability and Ethics, Sustainability and Stewardships, Sustainability, value and business strategy, Sustainability and Social, Sustainability and Culture, Sustainability and Environment, Sustainability and Law, Sustainability and Developed Countries, Sustainability and Developing Countries and Sustainability and SME.

- Sustainability and Green IT: Sustainability and Social Media, Sustainability and Online Community, Sustainability, Green IT and Internet, Innovation of Green Technologies, -Green Procurement, Green IT and Energy, Green IT and e-Waste, Technologies and Green IT, Green IT and Sustainable Design, Green IT Development and Sustainability, Green Supply Chain and Logistics, Sustainability and Green IT Policy and standards, Green IT and Sustainability and escorting to change, Sustainability and Green IT business, Sustainability and Green IT Infrastructure and Cloud computing and virtualization.

- Sustainability and Education: Education and Training, Accreditation, Green IT and teaching, Sustainability and Green Campus, Education for Sustainability, Sustainability and Curriculum frameworks, Shifting toward Sustainability, Sustainability and Future Generation and Sustainability and e-Society.

These events received 136 submissions from more than 25 countries. Each submission was reviewed in a double-blind review process by an average of four independent reviewers to ensure quality and maintain high standards. Out of the papers submitted, 32 got blind referee ratings that published them as full papers, which means that the acceptance rate was 24%. Some other submissions were published as short and reflection papers, doctoral consortium and posters.

Selected papers of the best papers from these conferences will be published as extended versions in the IADIS International Journal on WWW/Internet (IJWI) (ISSN 1645-7641), the IADIS International Journal on Computer Science and Information Systems (IJCSIS) (ISSN 1646-3692) and other selected journals and/or books.

In addition to the presentation of full papers, short papers, reflection papers, doctoral consortium and posters, the conference program also includes three keynote presentations from internationally distinguished researchers. We would therefore like to express our gratitude to Ms. Brenda Aynsley, OAM, Fellow ACS, Australia, Dr. Kathy Lynch, University of the Sunshine Coast, Australia and Associate Professor Pedro Isaias, The University of Queensland, Australia.

A successful conference requires the effort of many individuals. We would like to thank the members of the Program Committee for their hard work in reviewing and selecting the papers that appear in this book. We are especially grateful to the authors who submitted their papers to this conference and to the presenters who provided the substance of the meeting. We wish to thank all members of our organizing committee.

Last but not least, we hope that participants enjoyed Melbourne and their time with colleagues from all over the world.

Piet Kommers, University of Twente, The Netherlands
Tomayess Issa, Curtin University, Perth, Australia
Theodora Issa, Curtin University, Perth, Australia
Conference Co-Chairs

Elspeth McKay, RMIT University, Australia
Pedro Isaias, The University of Queensland, Australia
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Melbourne, Australia
December 2016

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KEYNOTE LECTURES

RIDING THE INNOVATION WAVE, AUSTRALIAN ICT PRACTICE IN A GLOBAL CONTEXT

By Ms. Brenda Aynsley,
OAM, Fellow ACS,
Australia

Abstract

How much should we be riding the innovation wave in 2017 and beyond?

That Australian possess a great deal of ingenuity is well know around the world. Our capacity to apply it to solve everyday problems is quite legendary. Some of the technology inventions showcased each week on programs like Shark Tank, including one by a 14-year-old boy, give me confidence that Australia can harness innovation to drive prosperity. However, a capacity for innovation is just a starting point.

While digital disruption is a reality and businesses need to respond both quickly and flexibly to changing market conditions, it is essential that we do so in a way that is also responsible and consider any limitations posed by issues such as privacy, security and the need to mitigate risk. We must ensure that we don't just innovate for the sake of it, but that we balance creative licence with ethics and accountability to deliver "responsible innovation".

That requires actors who understand this concept.

Finding the right balance between innovation that responds to the changing needs of a business and the disciplines required for effective ICT delivery is a significant challenge for many in ICT management.

This talk will address the issues inherent is "responsible innovation".

NON-DISCIPLINE GRADUATE SKILLS: REVIEW AND ASSESSMENT

By Dr. Kathy Lynch,
University of the Sunshine Coast,
Australia

Abstract

The need to identify the non-discipline skills our information technology graduates require to be successful contributors and collaborators in today's workforce has been studied for over a decade. Further, in more recent times their specific inclusion in university curricula has appeared. However, identification and development of specific non-discipline graduate skills are only two components of the puzzle; what now needs greater exploration, is a review of these skills and how to effectively and fairly assess these them.

This keynote demonstrates the need not only to review the non-discipline skills required by today's graduates but our obligation as curriculum developers and lecturers to fairly assess them to ensure that graduates are ready for the workforce they will enter.

LEARNING ANALYTICS: PAST, PRESENT AND FUTURE

By Associate Professor Pedro Isaias,
The University of Queensland, Brisbane,
Australia

Abstract

Learning Analytics (LA) has gained more importance with the years and now is currently playing a key role in student strategies. These strategies can be fully achieved through a proper and strategic use of LA.

This keynote introduces LA, looking at its origin, its objectives and how it works. Then it discusses LA's importance the current challenges and LA in practice with some examples being presented and analysed. Future directions are indicated and the LACE project is presented.

Full Papers

ECG IDENTIFICATION SYSTEM USING NEURAL NETWORK WITH GLOBAL AND LOCAL FEATURES

Kuo-Kun Tseng[1], Dachao Lee[1] and Charles Chen[2]

[1]*Department of Computer Science and Technology, Harbin Institute of Technology, Shenzhen Graduate School, Shenzhen, China*

[2] *School of Information Technology, Beijing Institute of Technology, Zhuhai, China*

ABSTRACT

This paper proposes a human identification system via extracted electrocardiogram (ECG) signals. Two hierarchical classification structures based on global shape feature and local statistical feature is used to extract ECG signals. Global shape feature represents the outline information of ECG signals and local statistical feature extracts the information between signals in time domain. Genetic algorithm based back propagation neural network is used as the specific classifier. Experiment results show that our identification system can achieves an average 97.6% accuracy on a 38 subjects of PTB public ECG database and an average 100% accuracy on an 18 subjects of MIT-BIH public ECG database, which demonstrates the proposed system can reach satisfactory effects.

KEYWORDS

ECG, Global shape feature, Local statistical feature, two hierarchical classification structures

1. INTRODUCTION

Automatic human identification using physiological modality has been widely researched as its significance in many security areas. A lot of works have been studied on human identification such as facial features (Samaria and Harter, 1994; Nagamine *et al*, 1992), gait (Kale *et al*, 2003), fingerprint (Hodges and Pollack, 2007), and iris (Zhu *et al*, 2000) etc. However, these biometrics modalities either can not provide reliable performance in terms of identification accuracy or are not robust enough against falsification. Electrocardiogram (ECG) is a method to measure and record different electrical potentials of the heart, which is considered to be a unique system of each person. The main reason to use ECG signals to identify individuals is due to its physiological and geometrical differences (Hoekema *et al*, 2001).

Recently, ECG signals for human identification have been widely studied. To build an efficient ECG human identification system, the very important element is the distinctive features extracted from ECG signals. Some methods are proposed for ECG feature extraction. Kyoso and Uchiyama (2001) present a system which identifies subjects based on a comparison of a person’s ECG with previously registered ECG feature parameters. These feature parameters are sampled from the intervals and durations of the electrocardiographic wave extracted using characteristic points appearing on the waveform of the second order derivative and are identified using discriminate analysis. Wang *et al.* (2013) proposed ECG signals for human identification based on sparse representation of local segments, which is extracted from an ECG signal and projected to a small number of basic elements in a dictionary. Biel *et al.* (2001) extracted attributes that are temporal and amplitude distances between detected fiducial points. They proposed two extraction methods called analytic-based method and appearance-based method.

In this paper, two different features of ECG signal have been extracted as global shape feature and local statistical feature. Due to the different representation information of those two kind features, a two hierarchical classification structure has been designed mainly spired by the idea of changing large class number problem to small class number problem. In the comparison phase, genetic algorithm based back propagation neural network (GA-BPNN) combined classifier is used.

The rest of this paper is organized as follows. The related works is presented in Section 2. Section 3 introduces preprocessing of ECG signals and two feature extraction algorithm. The two hierarchical classification structure is explained in Section 4. We give the experiment results in Section 5. Finally, our paper is ended with the concluding remarks in Section 6.

2. RELATED WORKS

Automatic and accurate human identification systems have become increasingly important in several aspects of daily lives, such as in access control, financial transactions, electronic commerce and other. Traditional strategies to accomplish identification (e.g., "password", "IDs") are no longer adequate to satisfy modern requirements. Compared to traditional methods, biometrics features are more reliable and secure in verifying individuals. There are two main biometrics features for human identification system, which can be refer to either physiological or behavioral. Physiological biometrics features commonly include face, fingerprints, retina, iris, and etc. Behavioral biometrics features include signature, voice, and etc.

An ECG signal describes the electrical activity of the heart over time and can be recorded noninvasively using electrodes attached to the surface of the body (Silipo *et al*, 1996). Advantages of using the ECG for biometrics recognition include universality, permanence and uniqueness, robustness to attack, aliveness detection, and data minimization (Agrafioti *et al*, 2011). Previous works about feature vectors measured from different parts of ECG signals for classification can be summarized as either fiducial points dependent or independent. Fiducial point dependent methods depend on local characteristics of the heartbeat, such as time duration, or amplitude differences between fiducial points. The non-fiducial point approaches extract features statistically based on overall morphology of waveform (Agrafioti *et al*, 2011).

Biel *et al.* (2001) used an equipment called SIEMENS to transfer and convert ECG to a usable format. A feature selection algorithm based on correlation matrix is employed to reduce the dimension of features. The method used to classify persons is SIMCA (Soft Independent Modeling of Class Analogy). The SIMCA model will find similarities between test objects and classes rather than identical behavior. The experiment tested 20 persons and 100% identification rate was achieved by using empirically selected features. Lack of automatic identification is the major drawback.

Saechia *et al.* (2005) proposed a human identification system using Fourier transform of ECG signal as feature extraction tool. Once the ECG signals are normalized to be based on the same heart rate, three subsequences are divided and corresponded to P, QRS, and T waves, respectively. From the resulted Fourier coefficients, only significant elements are selected and employed in neural network for classification. Among the using database, their experiment results show that the proposed system can identify 31 strangers of 35 individuals.

Wang *et al.* (2008) presents a systematic analysis for human identification from ECG data. A fiducial-detection-based framework that incorporates analytic and appearance attributes is introduced. Existing solutions for ECG signals recognition are based on temporal and amplitude distances between detected fiducial points. Such method heavily relies on the accuracy of fiducial detection. To completely relax the detection of fiducial points, a new approach based autocorrelation in conjunction with discrete cosine transform is proposed. Two public ECG databases (PTB and MIT-BIH) are used. Experiment results show the proposed framework can achieve 100% subject/individual identification.

3. PROPOSED METHOD

Human identification is essentially a pattern recognition problem which basically involves signal preprocessing, feature extraction, and classification. ECG signal is one of the most important biometric attributes and it can be used for human identification due to the fact that different individuals have different physiological and geometrical hearts, which displays certain uniqueness in their ECG signals.

ECG signals are the recordings of the electrical activity of the heart. It can be roughly divided into phases of depolarization and repolarization (Biel *et al*, 2001). The depolarization phases correspond to the P-wave and QRS-wave. The repolarization phases correspond to the T-wave. A basic ECG signal cycle is shown in Figure 1.

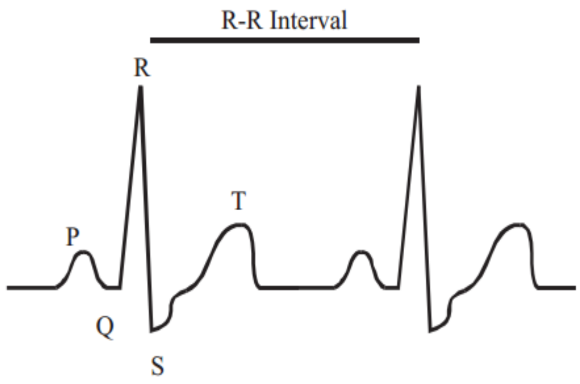

Figure 1. Basic ECG Signal Cycle

3.1 Preprocessing

The raw ECG signals usually contain low and high noise components (Israel *et al*, 2005). The low frequency noise is expressed as the slope of the overall signal across multiple heartbeat traces. The high frequency noise is expressed as the intra-beat noise. Reference (Israel *et al*, 2005) points out that three fundamental frequencies can be identified: the 60Hz electrical noise due to power line, the 1.10Hz heartbeat information and 0.06Hz change in baseline electrical potential. The remainder of the frequency is a combination of other noise source and subject information. The goal of filtering is to remove the 0.06 and 60Hz noise while retaining the individual heartbeat information between 1.10Hz and 40Hz. In this system, Butterworth band-pass filter is selected to perform noise filtering. The cutoff frequencies of the filter is 1Hz-40Hz based on empirical results.

Noise filtering preprocessing of ECG signal is to minimize the negative effects of noises. Figure 2 gives a graphic illustration of the applied preprocessing procedure.

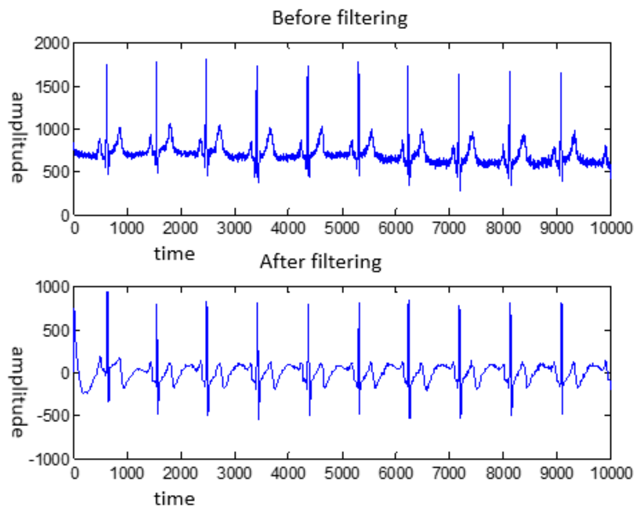

Figure 2. ECG signal preprocessing

3.2 Global Shape Feature

The ECG is non-periodic but highly repetitive signal. For one same person, the shape of R-R intervals of ECG signal is nearly the same. But for different people, the shape of R-R intervals is also some kind different. Global shape features are extracted based on this attribute. After preprocessing of one ECG signal,

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R points are found in the signal, and then ten R-R intervals are cut from the ECG signal to average into one interval.

Assume one person has n normal R-R intervals denoted as $S = \{S_1, S_2, S_3, \ldots\ldots, S_n\}$, then the average R-R length of these n normal R-R intervals calculated and denoted as $\mu = \sum_{i=1}^{n} |S_i| / n$, where $|S_i|$ is the length of S_i. If $|S_i| > \mu$, this R-R interval should be compress and the position of deleting point is at $\lfloor |S_i| / (|S_i| - \mu) + 1 \rfloor$; if $|S_i| < \mu$, this R-R interval should be fill with mean value of two points and one point is right before the position $\lfloor |S_i| / \mu - (|S_i|) + 1 \rfloor$ and one is right after the position. Make sure length of all the n R-R intervals are equal to μ now. We get the global shape feature G by $G_i = \sum_{j=1}^{n} S_{ij}$, where i=1, 2, 3,…., μ. Figure 3 shows the basic diagram of global shape feature extraction.

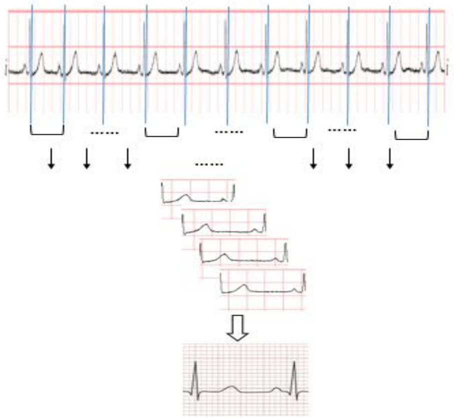

Figure 3. Diagram of global shape feature extraction

3.3 Local Statistical Feature

Local statistical feature are extracted based on statistical counting and ranking of binary patterns that converted by ECG signal samples. According to (Fufu and Tseng, 2012), some advantages of statistical based algorithm are: there is no need for QRS detection while running the algorithm and the result may still be robust to dynamic variation of ECG signals; variations of the length and the sampling rate of matching signals are allowed; the algorithm performs rapidly with low computational complexity.

Consider ECG signal as $S = \{x_1, x_2, \ldots x_i, \ldots\ldots x_n\}$, where x_i corresponds to the i_{th} input data. An interval-distance-set between x_i and x_j is denoted as $I = \{I_1, I_2, \ldots\ldots I_l\}$, where all I_i in I is integer and represent as a distance. According to interval-distance-set, compare each pair of consecutive input signals and categorise the data into one of the two cases: a decrease or increase in x_i. A preliminary reduced function then maps these two cases to 0 or 1, respectively, according to (1):

$$y_i = \begin{cases} 0, x_{i+Ip} \le x_i, 1 \le i \le n \\ 1, x_{i+Ip} > x_i, 1 \le p \le l \end{cases} \quad (1)$$

Equation (1) converts the ECG signal of length n to a binary sequence $Y = \{y_1, y_2, \ldots. y_{n-1}\}$ of length $n-1$. Group every m in Y into a rank order binary sequence of length m, referred to as an m-bit word; collect all such words to form a rank order binary pattern $B = \{b_1, b_2, . b_k, \ldots b_{n-m}\}$ where $b_k = \{y_k, y_{k+1}, \ldots., y_{k+m-1}\}$. We then convert each m-bit word b_k to its decimal expansion w_k. Next, count the occurrences of all w_k and sort them in order of descending frequency. For $k = 1, 2, \ldots., n-m$, define $j = w_k$. It is obvious that values of j range from 0 to 2^m-1 Let $p(j)$ be the corresponding relative frequency of j, $p(j) = n_j / (n-m)$ and $\sum_{j=0}^{(2^m-1)} n_j = n - m$, and it is the local statistical feature.

4. HIERARCHICAL CLASSIFICATION STRUCTURE

Global shape features and Local statistical features are two complementary representations of the characteristics of the ECG signals. An efficient integration of these two kinds of features will enhance the identification performance.

4.1 Back Propagation Neural Network

Back propagation, an abbreviation for "backward propagation of errors", is a common method of training artificial neural networks. The BPNN (Back Propagation Neural Network) algorithm learns the weights for a multilayer network, given a network with a fixed set of units and interconnections. It employs gradient descent to attempt to minimize the squared error between the network output values and the target values for those outputs.

Each training example is a pair of the form $< \vec{x}, \vec{t} >$, where $\vec{x}$ is the vector of network input values, and $\vec{t}$ is the vector of target network output values and η is the learning rate(e.g., 0.05). We denoted n_{in} as the number of network input, n_{hidden} the number of units in the hidden layer, and n_{out} the number of output units. The input from unit *i* into unit *j* is denoted x_{ji}, and the weight from unit i to unit *j* is denoted w_{ji}. First we create a feed-forward network with n_{in} inputs, n_{hidden} hidden units, and n_{out} output units. Initialize all network weights to small random numbers. For each $< \vec{x}, \vec{t} >$ in training examples, we do propagate the input forward through the network: Input the instance $\vec{x}$ to the network and compute the output o_u of every unit u in the network. The sigmoid unit first computes a linear combination of its inputs, and then applies a threshold to the result. In the case of the sigmoid unit, however, the threshold output is a continuous function of its input. More precisely, the sigmoid unit computes its output o as $o = \sigma(\vec{w} \bullet \vec{x})$ where $\sigma(y) = 1 \big/ (1+e^{-y})$. Then propagate the errors backward through the network. For each network output unit k, calculate its error term $\delta_k = o_k(1-o_k)(t_k - o_k)$. For each hidden unit h, calculate its error term $\delta_h = o_h(1-o_h)\sum_{k \in outputs} w_{kh}\delta_k$, then update each network weight $w_{ji} = w_{ji} + \Delta w_{ji}$ where $\Delta w_{ji}(n) = \eta \delta_j x_{ji} + \alpha \Delta w_{ji}(n-1)$. This is called adding momentum, which is a common way in weight-update rule.

4.2 Genetic Algorithm Based on Back Propagation Neural Network (GA-BPNN)

In recent years, genetic algorithm based on artificial neural network model as an objective or fitness function has been applied successfully in optimizing the input space of various bioprocess studies (Zhang *et al*, 2007). Genetic algorithm is an artificial intelligence-based stochastic non-linear optimization technique which solves optimization problems based on natural selection, the process that drives biological evolution. Using genetic algorithm is capable of finding both the weights and the architecture of a neural network, including number of layers, the processing elements per layer and the connectivity between processing elements.

4.3 Hierarchical Classification Structure

To better utilize the complementary characteristics of global shape feature and local statistical feature, a two hierarchical classification structure have been adopted mainly spired by the idea of changing large class number problem to small class number problem. In pattern recognition, when the number of classes is large, the boundaries between different classes tend to be complex and hard to separate. It will be easier if we can reduce the possible number of classes and perform classification in a smaller scope (Wang *et al*, 2008). Using a hierarchical architecture, we can first classify the input into a few potential classes, and a second-level classification can be performed within these candidates.

Figure 4 is the basic chart of the two hierarchical architectures. In the first step, we could use the global shape feature for classification using GA-BPNN. During this step, most unrelated subjects are filtered. If all the test samples can be classified as one subject, then the first GA-BPNN classifier can output this result directly. Otherwise, the local statistical features for classification using GA-BPNN filters the rest subjects.

This classification structure maps global classification into local classification and reduces the complexity and difficulty. Such hierarchical architecture can be applied to other pattern recognition problems as well.

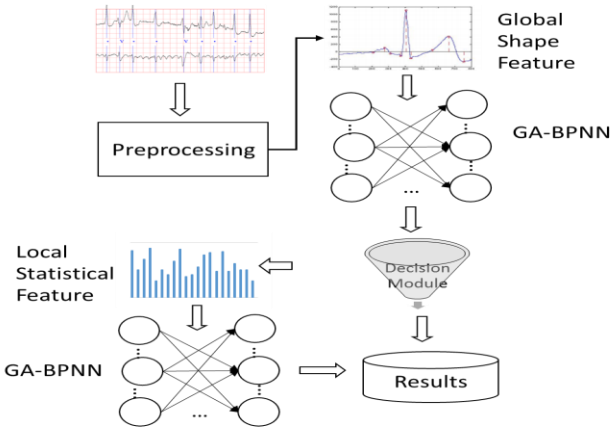

Figure 4. Hierarchical Classification Structure

5. EXPERIMENT AND RESULT

To evaluate the performance of our proposed methods, we conducted our experiments on two sets of public databases: PTB (Bousseljot *et al*, 1995) and MIT-BIH (Goldberger *et al,* 2000). The PTB database is offered from the National Metrology Institute of Germany and it contains 549 records from 294 subjects. Each record of the PTB database consists of the conventional 12-leads and 3 Frank leads ECG. The signals were sampled at 1000 Hz with a resolution of 0.5µV. The criteria for data selection are healthy ECG waveforms and at least two recordings for each subject. We randomly select 38 subjects from the total 294 subjects. The MIT-BIH Normal Sinus Rhythm Database contains 18 ECG recordings from different subjects. The recordings of the MIT database were collected at the Arrhythmia Laboratory of Boston’s Beth Israel Hospital. The MIT- BIH Normal Sinus Rhythm Database was sampled at 128 Hz.

We design our experiment by using nearest neighbor (NN) classifier, GA-BPNN, and hierarchical classifier, respectively. Either global shape feature or local statistical feature is used for single classifier. Combined those two features can work as a hierarchical classifier. In the Figure 5, G/L-NN represent for global shape feature/local statistical feature for NN classifier; G/L-GABPNN represent for global shape feature/local statistical feature for GA-BPNN; NN+GABPNN represent for using hierarchical structure with global shape feature for NN classifier and local statistical feature for GA-BPNN.

Experiment results show that for 38 subjects of PTB with identification accuracy rate 97% and 18 subjects of MIT-BIH with identification accuracy rate 100%. Both are get their best result when using hierarchical classification structure.

While compared to other similar methods, experiment results of the method we proposed show it can achieve reliable identification accuracy. The RBP method (Fufu and Tseng, 2012) can reach 95.791% in the identification accuracy at its best. The RBP method is similar to the local statistical feature extraction process and the difference is that we use a set of intervals other that the interval 1. In (Fufu and Tseng, 2012), a weighted distance formula (2) is defined to measure the similarity of two ECG signals:

$$D_m(S_1, S_2) = \frac{\sum_{k=0}^{(2^m-1)} |R_1(w_k) - R_2(w_k)|\, p_1(w_k) p_2(w_k)}{(2^m-1)\sum_{k=0}^{(2^m-1)} p_1(w_k) p_2(w_k)} \qquad (2)$$

where $p_i(w_k)$ and $R_i(w_k)$ represent the probability and ranking of w_k in the sequence S_i, i =1 or 2. The absolute difference between two rankings is multiplied by the normalized probabilities as a weighted sum; the factor 2^m-1 in the denominator is to ensure all values of D_m lie between 0 and 1.

The AC/DCT method (Wang *et al, 2008*) is a similar hierarchical classification structure using LDA classifier and nearest neighbor classifier. Wang *et al* (2008) proposed a feature extraction method without fiducial detection based on a combination of autocorrelation and discrete cosine transform. The AC/DCT method involves four stages: (1) windowing, where the preprocessed ECG trace is segmented into non-overlapping windows, with the only restriction that the window has to be longer than the average heartbeat length so that multiple pulses are included; (2) estimation of the normalized autocorrelation of each window; (3) discrete cosine transform over L lags of the autocorrelation signal; and (4) classification based on significant coefficients of DCT. The AC/DCT method offers 94.47% and 97.8% window recognition rate for the PTB and MIT-BIH datasets, respectively. The comparison is shown as Figure 6.

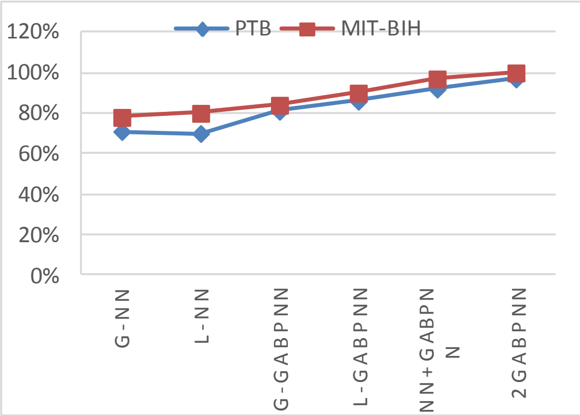

Figure 5. Comparison of experiment results

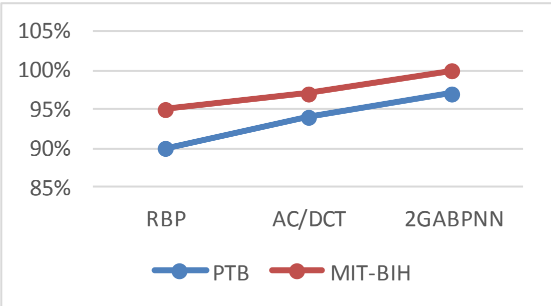

Figure 6. Comparison with other methods

6. CONCLUSION

This paper proposes a human identification system using global shape features and local statistical feature of ECG signals. The global shape features are extracted based on the characteristic of non-periodic but highly repetitive of ECG signals. Differences in the shape of their ECG signals between different individuals indeed exist. The local statistical features taking the advantage of local difference among samples in one signal. To better utilize the complementary characteristic of local statistical features and global shape features, a two hierarchical classification structure has been adopted, which is mainly spired by the idea of changing large class number problem to small class number problem. Experiment results show the two combined GA-BPNN classifier achieved better identification accuracy for both PTB and MIT-BIH databases. The idea of global feature combines local feature and using a hierarchical classification can be referenced by identification system using other biometric features.

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SMARTENING UP: ONGOING CHALLENGES FOR AUSTRALIA'S OUTBACK

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ABSTRACT

As the international community moves inexorably towards a *smart* future, the position of Australia's non-urban areas in that future is less certain. The (re-elected) Australian federal government made a commitment to moving Australian cities forward as part of the international *smart city* movement. However, the effectiveness of this commitment in enabling non-urban areas to attain the same level of *smartness* is unclear. This is particularly so in view of the delayed roll out of the NBN. The research examines the *smart* discourse for Australia's non-urban areas in the context of the federal government's *Smart Cities Plan.* In doing so the research pinpoints a hole in that plan and identifies matters specifically requiring government attention.

KEYWORDS

Digital Divide, Digital Inclusion, NBN, Digital Economy, Smart City

1. INTRODUCTION

The international community is moving steadily towards a *smart* future (Ratti & Claudel, 2016). This is evidenced in the increasing support for the adoption of *smart city* frameworks (Edwards, 2016; Zubizarreta et al., 2016; Bakıer et al., 2013). Governments, policy makers and industry all have jumped on the bandwagon, as seen in the variety of initiatives designed to capture the hearts and minds (and wallets) of those seeking to capitalise on hopes for the future. Importantly, a necessity of any *smart* framework is that, in order for its component digital aspects to work successfully, there must be effective access to the internet. In the digital economy a city or country's *"digital competitiveness"* now depends upon it enabling access to the internet as a utility service (House of Lords, 2015). Within Australia, however, the ability of existing (or proposed) *public* policies to extend a *smart* framework into rural and regional areas is questionable.

Australia's needs must be considered in the context of its ever growing population and where this now is, and in the future will be, located. Expanding communities need appropriate infrastructure to support their residents in the digital economy. As the Australian National Broadband Network ('NBN') will enable residents to be able to telecommute and engage in on line education more effectively, its non-urban population bases will become more significant (Florida, 2006); and yet many of these areas, without the ability to attract commercial investment, have inconsistent internet access (Cradduck, 2015). Concurrently the better level of services within urban areas, which are more easily serviced by commercial interests, will see an expanding number of Australian *smart cities* able to provide better digital engagements for their residents. However, this will result in the widening of the divide between 'digital-haves' and 'have-notes'. In order to stem the growth of this divide, there is a need for a minimum level of access throughout Australia to the essential infrastructure found more commonly in urban settings. Achieving effective internet access is the first step towards *smartness* as well as vital for Australia's social <u>and</u> economic growth (Gregory, 2015).

The paper examines the *smart* discourse in the context of the federal government's *Smart Cities Plan* in order to identify the challenges for *rural* and *regional* Australia. In doing so, it contributes towards beginning to fill the knowledge gap regarding the impacts of this digital divide for Australia. The paper commences by explaining what is meant by *smart* before overviewing the Australian context. It then highlights insights from other jurisdictions before identifying matters for specific consideration by the Australian federal government. The paper then identifies matters requiring specific attention in order to overcome the challenges for Australia's rural and regional areas. It concludes by suggesting a process for public policy development to enable *all* of Australia to work towards their collective *smart* future.

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2. EXPLAINING *SMART*

The *smart* discourse has moved beyond mere characterisation (Giffinger et al., 2007), to consider what is necessary for *smart* creation. However, while the *"strategic planning for smart city development"* tends to involve *"largely unexplored and interdisciplinary fields"* (Angelidou, 2014, p.S3), the discourse occurs more commonly only from a discipline specific perspective (i.e. town planning) (Hawkins, 2014), and thus often without reference to all relevant issues (Edwards, 2016; Cocchia, 2014; Cavada et al., 2014). It also has as its focus urban areas rather than non-urban environments.

Although not uniformly defined (Edwards, 2016) a *smart* framework is one that is established by implementing an ICT structure, which enables the population to be engaged *and* which supports the effective delivery of essential services to them (Caragliu et al., 2009). An effective *smart* framework is one that provides a range of financial, environmental, (Cavada et al., 2015) and health (Newman et al., 2014) benefits; as well as addressing complex transportation issues. Core to this is the need for effective access to the internet. The internet enables the integration of the ICT networks needed (Neirotti et al., 2014; Popescu, 2015; Lee et al., 2014); as well as enabling individuals (Cradduck, 2015; Kariyawasm, 2007). Simply, a *smart* framework is one in which your use of technologies and services is integrated in such a manner that both enables and supports your existence. Digitally skilled citizens will be crucial to the ongoing effectiveness of the digital economy (Belanche et al., 2016), however, they can be supported by ICT only if they are enabled to engage with it – for this appropriate access to the internet is required (Cradduck, 2015).

The desire, need and opportunities for seamless integration of ICT and service delivery are growing (Kariyawasm, 2007). A primary driver of ICT implementation is commercial entities, which often seek to capture market share in closed, contractually driven, relationships founded on a perceived ability to gain a financial reward. Various private, as opposed to public, interests have played (and still have) significant roles in the development of existing and emerging *smart* frameworks and their governance (Zubizarreta et al., 2016; Angelidou, 2014; Bakıer et al., 2013; Lombardi et al., 2012; Bouteligier, 2011). In this context the term *smart city* also is used as a *"branding and marketing concept",* although this is done more often without consideration of the need to ensure the actual interoperability of individuals with the technology available for their use (Vestergaard et al., 2016, p.39). In response, commentators and scholars are becoming increasingly critical of industry-lead visions as to what *smart* should be (Foth et al., 2016). Criticisms arise separately where significant portions of the population, i.e. those in non-urban areas or with other access constraints, remain unsupported by effective public policy (Gregory, 2015).

3. THE AUSTRALIAN CONTEXT

Data creation, use and sharing by means of use of ICT, plays a vital role in digital engagements. Issues of access to necessary infrastructure, or rather lack of access, can have serious impacts for non-urban areas and for Australia as a whole. Expanding communities will require appropriate frameworks to be established, in new areas and retrofitted in existing areas, to support their residents in the digital economy. These are required to be provided in rural and regional areas at the same time as in urban areas. However, in comparison to urban areas, research indicates the *smartness* of rural areas is declining (Repko and DeBroux, 2012). In Australia the cost of infrastructure provision in non-urban areas (exacerbated by Australia's dispersed population bases and vastness) in combination with an aging population base, lower incomes and other issues of social exclusion is creating a new digital divide (Park, 2016). This digital divide requires specific attention as a government priority if Australia's dispersed regional and rural areas are to achieve equivalent digital engagement with their urban cousins (Park, 2016; Cradduck, 2016).

Noting the particular difficulties facing rural and regional Australia, urban areas are presented with their own problems. ICT infrastructure is more effectively established within a considered urban planning environment (Bakıer et al., 2013); however, it will be necessary both to manage and use existing infrastructures; and support individuals in their use (Cradduck, 2015). Successful implementation of any framework will be achieved more easily in a greenfield area, without the constraints of dealing with existing infrastructure and systems (Angelidou, 2014). Nonetheless, by necessity, in order to implement any framework new infrastructure will need to be retrofitted into established areas (Edwards, 2016). This requires government-community coordination supported by appropriate regulation.

While noting the valuable lessons that may be provided from the experiences of oversees jurisdictions, some examples should be approached with caution. It is a geographic and economic reality that, as regards internet access provision, there is in fact not one jurisdiction that replicates the Australian conditions as to smallness of its total population; its dispersed population bases and focus on coastal fringes; or its other geographic extremes. Importantly, this is likely to mean that the appropriate infrastructure provider of the future will be one entity – or the government itself – in order to ensure the economies of scale necessary for this utility service provision. Notably, Western European jurisdictions, while providing useful comparisons generally, have issues arising under land use or competition laws that tend to be peculiar to the jurisdiction; with some land use laws having an even narrower regional focus (Zweigert & Kötz, 1998; Watson, 1974).

4. INTERNATIONAL OBSERVATIONS

International cases can provide useful information of the issues that may arise. As these examples grow it will be important to consider new developments as Australia progresses its policies in order to address its specific issues (Althaus et al., 2013; Gerrand, 2006; Charlesworth, 2006). The starting point it is suggested is to take the initiative to recognise and treat access to the internet the same as any other utility service (House of Lords, 2015). Several countries have done this by effectively making access to the internet a right. Finland has done this specifically, while others either have extended their universal service obligation (USO) to the internet (i.e. Brazil) (Rauen et al., 2011). Others have implemented separate broadband USO policies, for example Chile and India (Prasad, 2013); Jordan, Malaysia and Pakistan (ITU, 2012); the United States (Kruger & Gilroy, 2013) and Spain (Síndic de Greuges de Catalunya, 2013).

The rights of individuals to self-determination and participation in social, political and economic life, including participating in both the ‘real world’ economy and the digital economy, are fundamental.[1] In order to be able to exercise these rights individuals must be able to access the internet, which requires direct State recognition *and* support in order to enable effective access (Cradduck, 2015). The need to ensure access the internet by all individuals therefore is not one that can be delegated to commercial parties. Appropriate public policy development is fundamental. The policy development process is informed both by government policy makers and industry consultations (Angelidou, 2014; Bridgman & Davis, 2003).

As Howkins (2009) reinforced:

> Successful policies can only grow out of collaboration between government and business to ensure that, when they are implemented, they are appropriate and that, as new situations arise, so new regulations are prepared. (p.119)

The role of citizens in this process also is crucial in ensuring the effectiveness of the framework from both national and international perspectives (Cornwall & Gaventa, 2001).

As law is the only system by which enforceable rights can be protected and penalties imposed; the appropriate governance of the digital economy and its component parts, remains the role of government (Cradduck, 2015). A reconsideration of the role of public policy thus is vital, noting, however, there is not *one* solution as to what is an appropriate policy framework (Zubizarreta et al., 2016). As international experience reflects, if a policy is too broad it is unlikely to be successful (Shapiro, 2009). Most importantly therefore, any policy framework must work in practice (Angelidou, 2014; Edwards, 2001).

5. MATTERS REQUIRING AUSTRALIA’S ATTENTION

In its most recent report on the status of the digital economy, *The Global Information Technology Report 2016,* the World Economic Forum urges *“*[p]*olicymakers* ... to …*work with other stakeholders to swiftly adopt holistic long-term strategies for ICT development and lead in adapting government and leadership behaviors to ensure that ICTs deliver maxim benefits”* (World Economic Forum, 2016, p.v.). Regretfully, Australia’s *Networked Readiness* has declined in the last 12 months as now it is ranked only 18th overall out

[1] *International Covenant on Civil and Political Rights 1966* Articles 1, 3 and 25*; and* Human Rights Council’s *Resolution on the Promotion and Protection of Human Rights on the Internet* of July 2012, Articles 1 and 3.

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of 139 countries, which is a drop from 16th in 2015. Worse still, it is submitted, it has an inexcusable ranking of 57th for *Affordability* and 13th for its *Political and regulatory environment* (p.60). In comparison, Finland (while having its own issues to address (p.22)) currently is ranked 2nd overall maintaining its 2015 position; and ranking 13th for *Affordability* and 4th for its *Political and regulatory environment* (p.95). Clearly there is much for Australia to learn.

As it has committed to doing (DPMC, 2016) the federal government needs to ensure it in fact continues to actively work with and across all levels of government; and with all stakeholders to find a solution, or solutions, that work for all (Helsper, 2008). Most importantly it will need to ensure that any policy it seeks to introduce will work in practice (Angelidou, 2014) and will properly support all citizens and residents irrespective of their location as the ability to innovate is inextricably linked both to the requirement for appropriate infrastructure (World Economic Forum, 2016) and the capacity to access that infrastructure (Cradduck, 2015).

The *smart city* discourse, in addition to having as its focus urban environments and residents, presumes a level of access to services and infrastructure, including the ability to use those services (Foth et al., 2016). As the NBN continues to be rolled out, however, many Australia regions including some urban areas continue to be without access. To develop Australia in the digital economy requires enabling all its human capital (Belanche et al., 2016). Ensuring digital inclusion thus is a necessary aspect requiring consideration in order to ensure *smart* intra-operability. The starting premise for Australia is that the conversation should be about what is necessary to enable access to *internet* services *per se.* In order to achieve appropriate access, the requisite mindset is one that, similarly to electricity and water provision, treats the provision of access to the internet as access to a *utility service* (House of Lords, 2015).

As significant areas of the rest of the world continue to surpass Australia in terms of internet access and digital engagement, the need to ensure appropriate internet access for all now in Australia is vital. Although the intention is for the NBN to be the *"broadband infrastructure provider of last resort"* (Bureau of Communications Research, 2015, p.33) it will be many years until *"NBN deployment has reached maturity"* (Bureau of Communications Research, 2015, p.75). Therefore to delay consideration of relevant issues merely disadvantages individuals specifically and Australia as a whole (Cradduck, 2015). The extension of the USO to internet access *per se* will mean that individuals, irrespective of location, will be able to attain and maintain an appropriate level of physical access to the internet and lack of financial capacity will not constrain their engagement in the digital economy. Such action also would *"promote the regional spread of Internet services and stimulate the demand for broadband"* (Prasad, 2013).

Smartening the Outback will require support from regional and local government authorities and officials; community and industry stakeholders; and the various regulatory bodies. Conversely, Australia's top down approach to its telecommunications regime, where oversight is a power vested in the federal level of government to the exclusion of the States/territories and local government authorities, means that those with the closest connection to the impacts of a digital divide have reduced capacity to improve their regions. Nevertheless, as Australia has progressed beyond the minimum level of infrastructure to enable internet access, it now must look to adopt *"policies and strategies ... which make the Internet widely available, accessible and affordable for all"* (Tully, 2014, p.185). Enabling digital skills acquisition, particularly by those living in remote Indigenous communities (Telstra Foundation, 2014) and recent migrants (Alam and Imran, 2015), as well as those who otherwise elect not to engage (Calzada & Cobo, 2015), will be essential.

Current regulation is unsettled as Australian ICT requirements, NBN and telecommunications provision is subject to various and ongoing governmental reviews. These include the review of the federal government's proposed *Smart Cities Plan*, for which submissions closed on 24 June 2016. As at 22 September 2016 submissions to that review have not been made public nor has the federal government provided any indication of its likely response or when that can be expected. Separately, in its response to the Regional Telecommunications Independent Review Committee's Report on *The Regional Telecommunications' Review 2015*, which was tabled in federal Parliament on 22nd October 2015, the federal government highlighted it proposed reforms for the NBN in order to develop *"legislation to introduce a statutory infrastructure provider of last resort regime"* (Cth, 2016, p.4). More recently the Productivity Commission commenced a review into the adequacy of the current USO (Productivity Commission, 2016). However, this review has only just commenced with submissions closing on 21 July 2016. While the final report is not expected until April 2017, a draft report is projected for December 2016.

Ensuring the *smartness* of rural and regional areas cannot, nor should it, be solely the responsibility of the federal government. Similarly to overseas jurisidicitons, various private interests, notably the ICT industry, continue to play significant roles in existing frameworks and their governance (Zubizarreta, et al., 2016). However, while industry has a policy development role (Howkins, 2009; Bridgman & Davis, 2003) the creation of public policy is a function of government, in this instance the federal government, and it is not a role that is appropriate for delegation. In addition to industry, local governments will have key roles in the process, noting that while there is much that local governments can do for their communities they require appropriate legislative empowerment (Cradduck, 2017) and State/territory and federal level support so to do.

At a federal level the emphasis of the (newly re-elected) federal government's to facilitating *smartness* through appropriate public policy is reflected in its significant commitments to funding, infrastructure support, as well as to inter-governmental collaborations (DPMC, 2016). Its commitment to assisting local governments to find collaborative solutions to long-term problems also falls within its more recently announced *Smart Cities and Suburbs Program* (DPMC, 2016a). However, the *Smart Cities Plan*, unfortunately, commences by defining the areas it will benefit by exclusion. This is done by clearly stating *"So when we talk about Australians cities, we mean both metropolitan and regional"* (DPMC, 2016, p.6). This is inappropriately limiting as it focusses attention away from those areas in greatest need of government support in order to ensure that appropriate physical and technological infrastructures are constructed/provided (Cradduck, 2015). As highlighted by the *Macquarie Park Case Study* (DPMC, 2016 p.10) the need for a minimum level of access to the essential infrastructure found more commonly in urban areas, is vital for Australia's future economic growth. It also is vital for its social development (Gregory, 2015).

The role of all levels of Australian government in enabling Australia's residents in, and the development of its, digital economy will not end with the physical establishment of the NBN. As new and better technologies arrive there will be *"a continued need to support people and communities in accessing technology and in acquiring the literacy skills required"* to engage with those new technologies (Helsper, 2008, p.15). Enabling digital skills acquisition, and upskilling, particularly by those living in remote Indigenous communities (Telstra, 2014) and recent migrants (Alam & Imran, 2015), as well as those who otherwise elect not to engage (Calzada & Cobo, 2015), will be essential to all Australia.

5.1 Policy Development

Cognizant that any delay in implementation of an appropriate *smart* framework may serve only to increase the digital divide in rural and regional areas (Park, 2016); it remains important that public policy is developed properly. An appropriate policy development process is one that is necessarily iterative and therefore requires time in order to be developed. The process commences with issue identification and problem definition, moving through data collection and consultation stages, to implementation, and post implementation evaluation and refinement to ensure effectiveness in practice (Cradduck, 2015, p.93 – considering Edward, 2001). Importantly, in order to be effective a policy solution must draw together various diverse perspectives from a number of disciplines (Edwards, 2016) and stakeholders into one holistic and workable policy.

A policy to enable the *smartness* of rural and regional areas therefore is one that would be developed by a rigorous (Howkins, 2009), balanced and inclusive (Bishop & Davis, 2002) yet targeted process, which engages with all relevant stakeholders – governments, industry, professions, community groups and individuals. Focus groups and selected interviews will be essential in order to understand the specific needs and concerns of rural and regional areas to ensure these are appropriately included within the resulting *smart* policy framework. Conscious that laws when created bind all citizens (Engle, 2008), a core aspect of the policy development process will be testing the policy and laws in practice.

In order to develop an appropriate policy a variety of matters must be considered, which includes the ability to use ICT for surveillance and control (Shaw, 2015; Richards, 2013); competition issues (Atkinson, 2009) privacy fears (Edwards, 2016; Maras, 2015); safety (Vestergaard, 2016); and other security concerns (Almeida et al., 2015); Gregory, 2015); and issues of ongoing governance responsibility once implementation of related infrastructure and or ICT network is completed (Althaus, et al., 2013). However, while industry has a policy development role (Howkins, 2009; Bridgman & Davis, 2003) the impact of such matters on both individuals and Australia as a whole means developing an appropriate governance framework to support them into the future should not be left purely to market forces.

6. CONCLUSION

Australia's growing population will lead to increased urbanisation, both by migration to existing cities and increased urban sprawl. Concurrently, improved telecommunications facilitated by the ongoing roll-out of the NBN will see rural and regional population bases become more significant as their citizens, no longer needing to commute for work or education; will remain more engaged within their local communities. Regulatory matters that will require specific and ongoing attention include effecting integration with existing infrastructure; ensuring privacy and data security; enabling digital inclusion (including ongoing digital literacy); governance and maintaining effective market functioning.

While the *Smart Cities Plan* and other policy initiatives remain under review, Australia's digital future is effectively in limbo. In the meantime, it is anticipated that commercial interests will continue to pursue *smart* objectives where financially viable so to do but in most instances not without such incentives. Acknowledging that *smartness* requires access to the internet, which can be enabled by a variety of means, the federal government's focus should be on *what* is delivered (i.e. access to the internet *per se*, and thereby access to the various services, information and communications that it enables) and not on *how* it is delivered (i.e. cables, WiFi, mobile phone technologies, or something not yet invented). This also will assist with drafting the policy and related law/s, which will implement the policy, as it will enable these to be written in a technology neutral manner. In turn this will assist with future proofing both. The result being that these then will be best positioned to adapt to, and encompass, future developments.

Government intervention is *essential* not optional. A new approach is required to develop Australia's *smartness* into the future and this is one that concurrently must encompass rural and regional areas; and urban areas, to ensure no-one is left behind. While the market and commercial interests have a role in enabling internet access and service provision, current experience evidences that in many areas and for many persons, access will not be enabled absent specific and easily enforceable legislated obligation. Implementing policies and laws to address this as a first step on the path to *smartness* is crucial. The consequence of not doing so will only be to further widen the already wide digital divide.

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EXTRACTION OF GRAPH INFORMATION BASED ON IMAGE CONTENTS AND THE USE OF ONTOLOGY

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ABSTRACT

A graph is an effective form of data representation used to summarize complex information. Explicit information such as the relationship between the X- and Y-axes can be easily extracted from a graph by applying human intelligence. However, implicit knowledge such as information obtained from other related concepts in an ontology also resides in the graph. As this is less accessible, automatic graph information extraction could prove beneficial to users. In this study, we proposed a novel method for extracting both explicit and implicit knowledge from graphs. This was based on our ontology that uses essential information pertaining to the graph and sentence dependency parsing. We focused on two graph types: bar graphs and two-dimensional (2D) charts. Different graph types require different extraction methods and have different extractable features. From the bar graph, we extracted axis labels, the global trend in the data, and the height of the bars. From the 2D charts, we additionally obtained local trends and regression types. The objective was to propose a method for acquiring the implicit and explicit information available in the graphs and entering this into our ontology. For evaluation purposes, we simulated an inquiry involving five questions. Accurate answers were retrieved and significant results were achieved by the shared concepts used in our ontology.

KEYWORDS

Graph information extraction; Ontology; Optical character recognition; Natural language processing

1. INTRODUCTION

Data reported in the academic literature is presented in many formats, including both digital and hard copy. Although readers must read the literature extensively to comprehend the data, its conclusions may be unclear if only descriptive details are available. Graphs are a form of data representation that help readers analyze and extract the information they need, making understanding easier. In a previous study (Kanjanawattana and Kimura, 2015), we attempted to interpret explicit and implicit information in a graph based on a strong relationship between the X- and Y-axes labels and by using information extracted not only from the axis labels themselves but also from data section. The information provided by the axis labels includes implicit knowledge; although not presented directly in the graph, it can be extracted by applying ontology. Human readers find it easier to interpret explicit information presented in a graph; comprehending implicit information is more difficult. A system that allows information to be extracted from a graph can therefore be expected to provide a powerful new approach to knowledge acquisition.

The capture of image semantics has opened up a new field of study that integrates several disciplines to address problems such as semantic gaps (Deserno et al., 2009; Mezaris et al., 2003). To enrich the semantics available from the graph images, we introduced a solution that minimizes the existing problem by using both textual and graphical content from the graph. Several previous studies have focused on the extraction of information based on graph components (Kanjanawattana and Kimura, 2016; Kataria et al., 2008) and the context of the graph (Huang et al., 2005). Kataria et al. (2008) introduced a method for automatically extracting graph elements including data points, axis labels, and legends, and addressed the problem of the overlap between text and data points. Each graph component plays a different role in data interpretation. For example, the axis labels represent a strong relationship and the data points provide real data correlated with the axes. Previous studies used information from these components. However, the focus has been on the

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extraction of data components rather than the semantics of the image. Huang et al. (2005) attempted to associate the recognition of textual and graphical information within two-dimensional graphs and captured the semantic content conveyed by graph images. Their approach was to individually identify the texts and graphics in the input image and then combine the extracted information to develop a complete understanding.

The image data used in this study was a collection of line, plot, and bar graphs from journal articles. A bar graph represents the data as bars with lengths proportional to their values. Line and plot graphs are called two-dimensional (2D) charts in this study. We selected graphs containing only single data sets to simplify interpretation.

In this study, we proposed a novel method for extracting the explicit and implicit information present in the data part of the graph. We used a combination of techniques, including ontology, optical character recognition (OCR), and natural language processing (NLP). We addressed the core problem of the semantic gap by making use of both the context of the graph based on the wider document and the graphical content of the graph itself. The objectives of the study were automatic extraction of hidden information using ontology, including the interpretation of explicit information extracted from the data within the graph, and creating ontology of graph information. Our intelligent system offers social benefits, as it can give access to implicit knowledge. It has a range of applications, for example in image interpretation and image search systems. A novelty of the study is that our method was able to extract useful information from the data section of the graphs as well as obtain explicit and implicit information from the relationships within the graph.

2. METHODOLOGY

2.1 Ontology

The ontology used was an extension of that in a previous study (Kanjanawattana and Kimura, 2016). As shown in Figure 1, it supports not only sentence dependency parsing but also graph components and data extracted from graphs. Protégé was used to build the RDF files expressing the ontology. We had already tested its reasoner to validate the generated ontology.

Our ontology included 26 classes and many relations. The main class was the GRAPH class, representing the concept of images from the graph. We used the TYPE class to identify the type of the graph such as bar graph or 2D chart. The 2D chart represents two different graph types: line and plot. We merged these into a single type because of their similar characteristics. Lines in a line graph are formed by combining a large number of plotted points.

Most images were described by their captions and optionally by links to paragraphs. These were represented as CAPTION and PARAGRAPH classes, respectively, and were related to a TOKEN class that stored the concepts of the tokens. Our system assigned part-of-speech (POS) tags and named entity recognition (NER) to each token. We also created dependency relations to represent a typed dependency connecting the tokens in a sentence such as determiner (det) and nominal subject (nsubj).

We identified the basic graph components of axis labels and legends because all graphs use these to represent significant information. For example, the legends of the X- and Y-axes show the relationship between two dimensions. These were therefore made a central part of our ontology. The GRAPH class was related to the COMPONENTS class by a HAS property. The COMPONENTS class comprised three subclasses: X-TITLE, Y-TITLE, and LEGEND. Note that we used only graphs presenting a single data set so that the legend, which shows data labels, was not always essential.

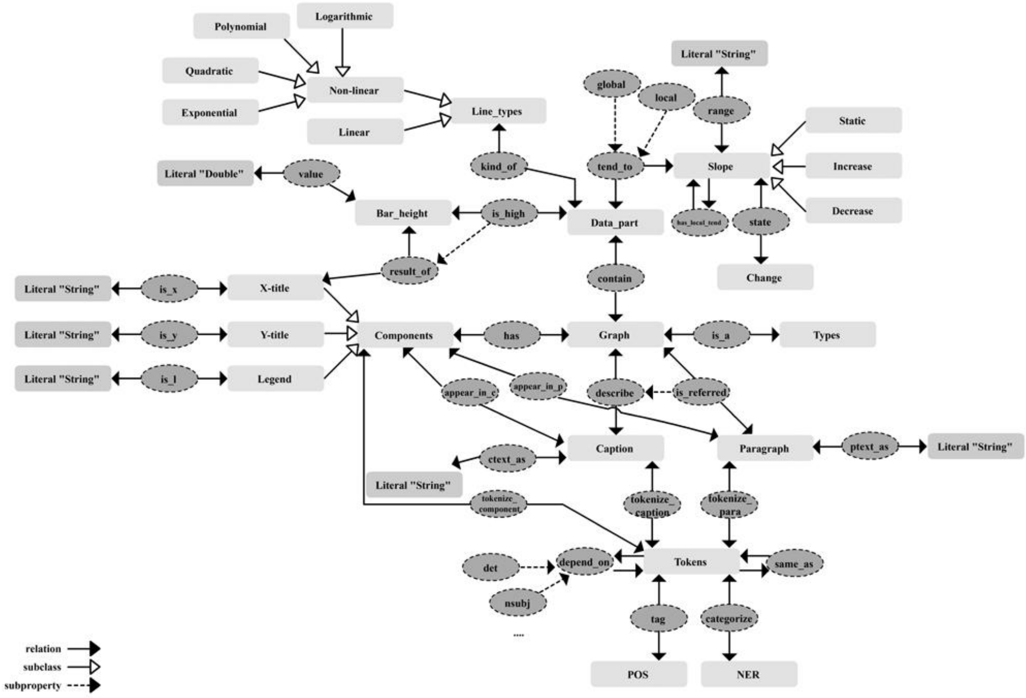

Figure 1. Representation of our ontology structure describing classes, properties, and relations

The real information appears in the data presented in the graph and was recorded as a DATA_PART class. This part of the graph displays a graphical representation of the data, for example by the height of the bar or the slope of the line. The data in a bar graph is represented by rectangular bars corresponding to the categories shown in the X-axis title. A BAR_HEIGHT class was introduced to represent the bar height. 2D charts use plots to show statistical data in a dimensional space. Our approach explored the types of lines used (e.g., linear or non-linear) to represent the data in the graph. This helped predict unseen directions in the data and provide new information that was not described in the caption and paragraphs. We also analyzed and collected both global and local tendencies in a SLOPE class comprising three different trends: an increase (INCREASE class), a decrease (DECREASE class), and no change (STATIC class). The global tendency represents the overall trend in the data while the local tendency provides information about where and how the trend changes. These concepts were described in a CHANGE class.

2.2 Extraction of Graph Information

The core of our study was the introduction of an effective method for extracting significant information from the data part of the graph, including the graph components, and adding this to our ontology. Our proposed method had two steps.

2.2.1 Data Content Identification

We first identified the existing graph components (e.g., X-axis title, Y-axis title, and optionally the legend), including the actual data. As different types of graph provide different information, our system needed a method for analyzing information from each type.

The features generally used for interpreting a bar graph are the X-axis title, the Y-axis title, the height of the bars, and a global tendency corresponding to the centers of the bars. To extract the graph components, the graph image must be partitioned horizontally to acquire the X-axis title and vertically to acquire the Y-axis title. We used OCR to recognize these. However, the occasional presence of irrelevant information such as parts of the bars or numbers may cause misrecognition by the OCR. To address this, we applied a method of automatic graph component extraction described in our previous study (Kanjanawattana and Kimura, 2016).

This method uses a technique of pixel projection to obtain a horizontal profile and remove unnecessary information. This provided cleaned graph components. To interpret bar graphs, we analyzed the height of the bars and the categories on the X-axis.

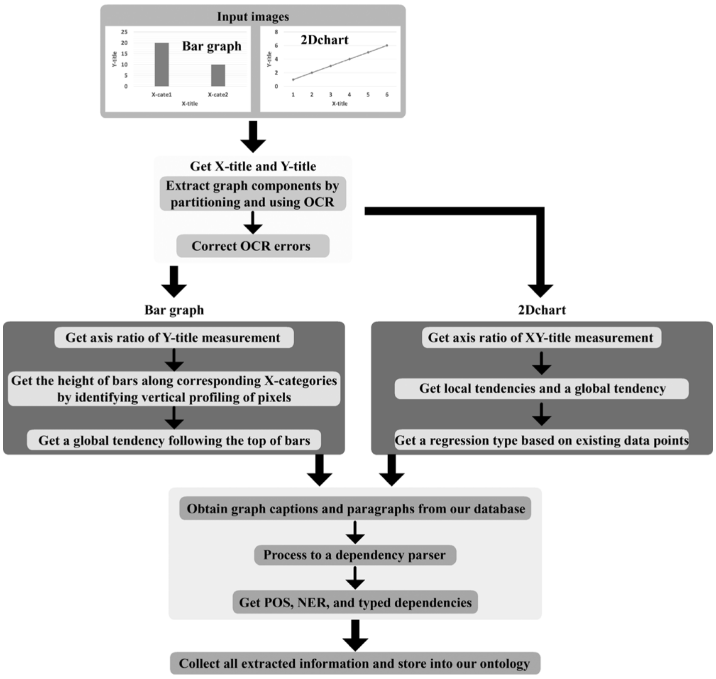

Figure 2. Bar height extraction based on pixel projection and a step function

Our system was able to extract the height of the bars automatically, as shown in Figure 3. After acquiring the cleaned X-axis legend, we used pixel projection with vertical profiling to locate the positions of the bars and their labels. Note that the position of the bars and the labels correspond. When identifying the height of the bars, we applied a step function to smooth the results of the pixel projection and find the center of each bar. We then measured a specific range, equal to half the distance between two neighboring centers, which independently covered each center; we then identified the value of the highest peak within the range. Finally, the graphical bar heights were acquired. However, these values do not match the true scale of the bars, because the proportion of pixels used in each graph varies depending on the data presented. Therefore, the actual bar height must be computed by multiplying the pixel proportion.

We introduced the two-step method of calculating the pixel proportion shown in Figure 4; the steps are data preparation and Y-scale measurement. For data preparation, we initially selected the leftmost partition containing both the Y-axis title and axis measurement after partitioning the graph image. The Y-axis title is irrelevant to the pixel proportion and only the measurement part was retained. Numbers and their respective positions were recognized using OCR. The next step was Y-scale measurement. We obtained the position of each result identified by OCR and measured the difference between two neighboring recognitions, including the difference in vertical distance. We then divided the difference between the two neighbor recognitions by the difference in vertical distance to obtain the actual number of scale units per pixel. We were then able to calculate the actual value of bars by multiplying the height of the bars with the scale units obtained. The global tendency was analyzed from the centers of the bars by calculating the slope.

The main feature of a 2D chart is a line or group of data points. We therefore analyzed the graph components, the global and the local tendencies as well as the regression type. The extraction process for a 2D chart was the same as that for a bar graph component. We initially neglected the titles of both axes to capture the data part. We converted the image to pixel values representing data points in the graph. The global tendency was identified using a global slope derived from the data points. We also attempted to perform a regression analysis using a mathematical library and identify the type of regression that was best suited to the data points using the smallest squared error. Both linear and non-linear regressions were used, including logarithmic, polynomial, quadratic, and exponential regressions.

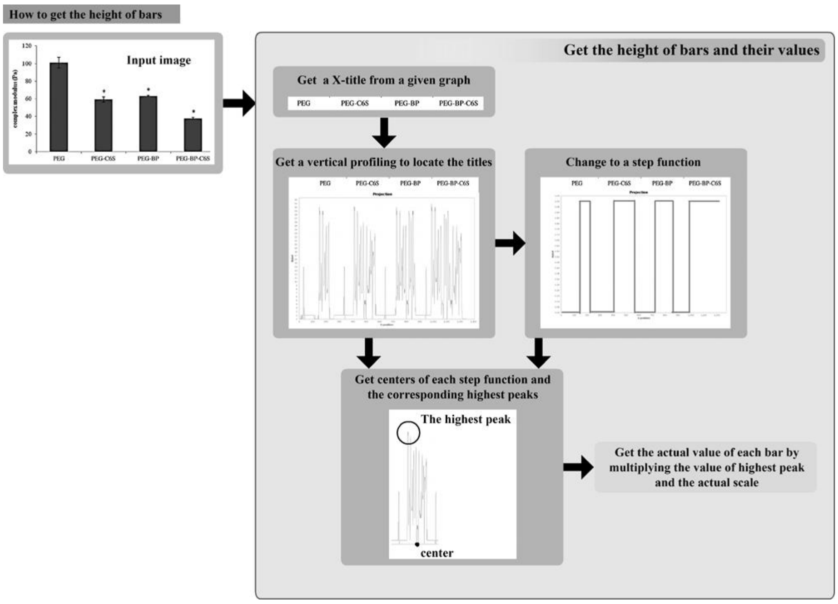

Figure 3. Bar height extraction using pixel projection and a step function

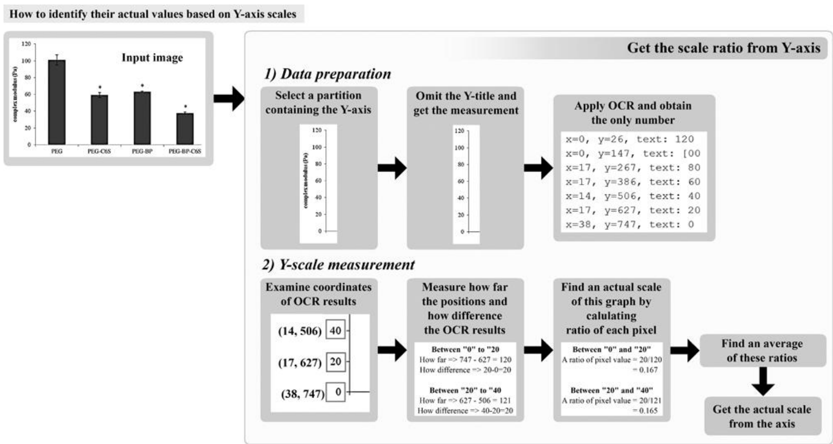

Figure 4. Pixel proportion calculation

A discontinuity in the slope may represent critical information. For example, a line graph may show the oxidation of a chemical substance against temperature and time, while a slope change indicates the saturation point. In recognition of the importance of such local tendencies, we analyzed the trend at each pair of pixel values. If a change was noted between any pair, the change in slope and the position were recorded.

2.2.2 Ontology Construction

We constructed the classes and relations following our earlier ontology design. The graph contents, such as captions and paragraphs, were stored in a database. These graph descriptions were given in sentences produced by tokenization, as a first step in building the ontology. A dependency parser identified the sentence structures, NER, and POS tags. We endeavored to allocate each word to a category using queries in DBpedia. The queried categories were represented as the NERs of tokens.

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3. EVALUATION AND RESULTS

In this study, the expected outputs were an ontology. Our method provided precise information for the construction of the ontology. To validate our method and ontology, the following questions were applied to the ontology:

1. What graph are both "blood" and "Hemoglobin" related to?
2. How do aphid populations impact sugar?
3. What is the tendency of the number of genes related to green fluorescent protein (EGFP) expression?
4. What value of Lipopolysaccharide (LPS) is described in all graphs and what is its relation?
5. What is a relation between Hemoglobin and Hemoglobin A1c (HbA1c)?

Query

```
SELECT ?graph
WHERE {
 {
  base:blood rdf:type graphContentOnto:Token ;
  graphContentOnto:tokenize_caption ?caption.
  ?graph rdf:type graphContentOnto:Graph ;
 graphContentOnto:describe ?caption.
 }UNION{
 base:hemoglobin rdf:type graphContentOnto:Token ;
  graphContentOnto:tokenize_caption ?caption.
  ?graph rdf:type graphContentOnto:Graph ;
 graphContentOnto:describe ?caption.
 }UNION{
 base:Hemoglobin rdf:type graphContentOnto:Token ;
  graphContentOnto:tokenize_caption ?caption.
  ?graph rdf:type graphContentOnto:Graph ;
 graphContentOnto:describe ?caption.
 }
}
```

Results

1 base:ijms-39-130.PMC3957012_figure1_1_bar
2 base:alm-32-17.PMC3255499_figure2_1_2Dchart
3 base: base:alm-32-17.PMC3255499_figure3_1_2Dchart

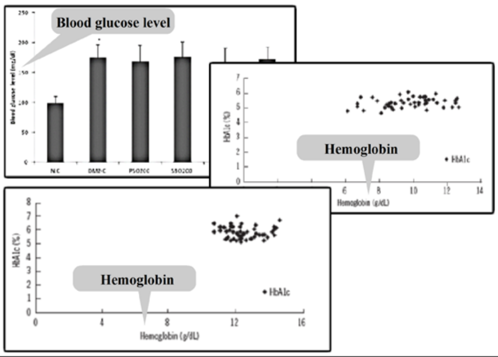


Figure 5. SPARQL query command and answers for the first question

Query

```
SELECT
(SAMPLE(?cate) AS ?category)
(SAMPLE(?number) AS ?value)
WHERE {
?graph graphContentOnto:contain ?data_part ;
        graphContentOnto:describe ?caption ;
        graphContentOnto:is_referred ?para .
?data_part graphContentOnto:is_high ?bar_height .
?bar_height graphContentOnto:value ?number ;
              graphContentOnto:result_of ?xtitle .
?xtitle graphContentOnto:is_x ?cate .
base:aphid rdf:type graphContentOnto:Token ;
             graphContentOnto:amod base:populations .
{base:aphid graphContentOnto:tokenize_caption
?caption  .}
   UNION
{base:aphid graphContentOnto:tokenize_para ?para  .}
}GROUP BY ?cate ?number
```

Results

1 "GUI" 28.2
2 "Glc" 28.4
3 "Control" 27.733333333333334
4 "Fru" 27.133333333333333
5 "Suc" 26.866666666666667
6 "Raf" 28.2
7 "Suc" 26.466666666666665

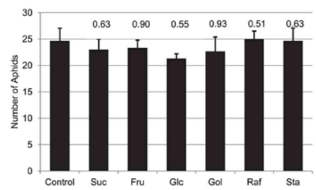


Figure 6. SPARQL query command and results for the second question

Query

```
SELECT ?graph ?slope
WHERE {
base:EGFP graphContentOnto:tokenize_caption
?caption .
base:genes graphContentOnto:tokenize_caption
?caption ;
graphContentOnto:nmod base:number .
?graph graphContentOnto:describe ?caption ;
 graphContentOnto:contain ?data_part .
 ?data_part graphContentOnto:global ?slope.
}
```

Results

1 base:pone.0048668.PMC3490874b_figure3_b_2Dchart base:decrease
2 base:pone.0048668.PMC3490874c_figure3_c_2Dchart base:decrease

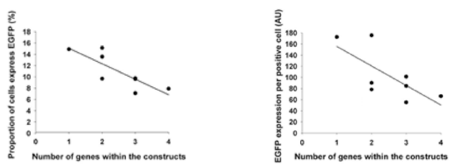


Figure 7. SPARQL query command and answers for the third question

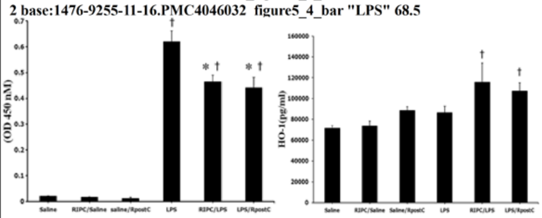
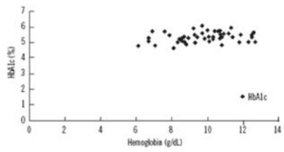
<table>
<tr><th>Query</th><th>Results</th></tr>
<tr><td>SELECT ?graph ?xtitle ?number
WHERE {
base:LPS graphContentOnto:tokenize_component ?component .
?graph graphContentOnto:has ?component.
?component graphContentOnto:is_x ?xtitle.
?bar_heightgraphContentOnto:result_of ?component.
?bar_height graphContentOnto:value ?number .
FILTER regex(?xtitle, "^LPS$", "i")
}</td><td>1 base:1476-9255-11-16.PMC4046032_figure4_5_bar "LPS" 79.5
2 base:1476-9255-11-16.PMC4046032_figure5_4_bar "LPS" 68.5

</td></tr>
</table>

Figure 8. SPARQL query command and answers for the fourth question

<table>
<tr><th>Query</th><th>Results</th></tr>
<tr><td>SELECT
(SAMPLE(?token) AS ?Subject)
(SAMPLE(?token2) AS ?Predicate)
(SAMPLE(?token3) AS ?Object)
WHERE {
base:hemoglobin graphContentOnto:tokenize_caption ?caption .
base:HbA1c graphContentOnto:tokenize_caption ?caption .
base:A1c graphContentOnto:tokenize_caption ?caption .
?token graphContentOnto:tokenize_caption ?caption.
{?token ?rel ?token2 ;
graphContentOnto:tag base:noun;
?a base:hemoglobin.
}UNION{
?token ?rel ?token2 ;
graphContentOnto:tag base:noun;
?a base:HbA1c.
}UNION{
?token ?rel ?token2 ;
graphContentOnto:tag base:noun;
?a base:A1c.
}
?token2 ?rel2 ?token3 .
?token3 graphContentOnto:tag base:noun.
?rel rdfs:subPropertyOf graphContentOnto:depend_on.
?rel2 rdfs:subPropertyOf graphContentOnto:depend_on.
}GROUP BY ?token ?token2 ?token3</td><td>1 base:hemoglobin base:levels base:plasma
2 base:HbA1c base:levels base:correlation
3 base:hemoglobin base:levels base:correlation
4 base:HbA1c base:levels base:plasma
5 base:HbA1c base:hemoglobin base:A1c
6 base:HbA1c base:hemoglobin base:levels
7 base:HbA1c base:levels base:Correlation
8 base:hemoglobin base:levels base:Correlation
9 base:HbA1c base:A1c base:Abbreviation
10 base:hemoglobin base:A1c base:Abbreviation
11 base:hemoglobin base:levels base:Quantification
12 base:HbA1c base:levels base:Quantification


The caption is "Correlation between hemoglobin and HbA1c levels in patients after 1 month of treatment. Abbreviation: HbA1c, hemoglobin A1c."</td></tr>
</table>

Figure 9. SPARQL query command and answers for the fifth question

Note that all our input graphs were in the field of biology, as the data were collected from journals available through PubMed. SPARQL queries were built to retrieve the related classes and relations of the ontology. The simulation was meant to model a user attempting to use our ontology and deciding what kind of question should be asked.

The SPARQL queries and their results are presented in Figures 5–9. Figure 5 shows the query command and the results obtained for the first question. Three graphs presented by Nekooeian et al. (2014) and Sinha et al. (2012) mentioned "blood" or "Hemoglobin" in their captions. Figure 6 shows a graph by Cao et al. (2013), with the values of each bar representing the impact of aphid populations on sugar. Figure 7 presents answers to the third question from a graph relating the number of genes and the EGFP expression by Gao et al. (2012). Figure 8 shows how our SPARQL query interrogated the ontology to retrieve graphs by Kim et al. (2014) pertaining to LPS and includes its values. Figure 9 shows the results for the correlation between "Hemoglobin" and "HbA1c" in a graph presented by Sinha et al. (2012). This displayed all tokens that had at least one relation with the specified tokens. For quantitative evaluation, we analyzed the precision and observed errors that arose in the course of the simulation. For the aforementioned five questions, we obtained relevant answers by using five queries. However, errors arose due to OCR misrecognition. These were ignored because they were not related to the validity of the ontology.

4. DISCUSSION

In this study, we proposed a new method of extracting information from a graph based on the use of ontology. We extracted the graph components and data located in the data section of the graph. A dependency parser was applied to analyze the captions of the graph and related paragraphs. The category to which each token belonged was acquired from DBpedia. The method was then applied to a graph-based

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search engine with user queries in the field of biology. The goal was to use the ontology to extract both implicit and explicit information from the graphs. Five inquiries were run, and the answers returned were, in the main, correct. Unfortunately, in some cases (e.g., the second question), failures in OCR introduced errors. The accuracy of the results provided evidence that our method was able to precisely extract information from the graphs. For the fifth question, answers were found from the captions of the retrieved graphs and several triples representing tokens that were connected by dependencies were obtained. Interestingly, we were able to retrieve tokens that were not available from the captions of the graphs, but were instead taken from other graphs sharing the same concepts such as “quantification” and “plasma.” Based on this result, we believe that our ontology is suitable for use in inquiries involving information pertaining to a graph. However, a limitation of the study was that we focused only on a limited set of graphs: line, plot, and bar. Our system does not yet support analysis of other graph types that require a different method of interpretation. Moreover, the system currently cannot deal with multiple data.

5. CONCLUSIONS

We developed an effective method for extracting graph information, and an ontology to support the dependency parsing of English sentences. Several techniques were combined to achieve this: OCR, NLP, and ontology. We evaluated the method by using the constructed ontology to address five questions. Accurate answers were obtained and significant results were achieved by the shared concepts used in our ontology, thereby demonstrating the effectiveness of the method. In future studies, we will develop the system further by building a simple user interface and extending the dataset to allow quantitative evaluations. We may also extend the domain of search data to other fields such as engineering.

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APPLICABILITY OF DOMAIN-SPECIFIC APPLICATION FRAMEWORK FOR END-USER DEVELOPMENT

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ABSTRACT

It is preferable for business professionals to develop web applications which must be modified frequently based on their needs. A website for matching is a typical example because various matching websites for C2C (Consumer to Consumer) have recently been opened in relation to the "sharing economy". In our case studies on end-user development, web applications are developed using domain-specific application frameworks. Applicability of these domain-specific application frameworks has a tradeoff relation with programming granularity in which business logic is expressed. The template for the business logic definition based on three-tier architecture of user interfaces, business logic and databases improves the applicability.

KEYWORDS

Application Framework, Web Application, End-User Development, Applicability, Three-Tier Architecture

1. INTRODUCTION

Most web applications are developed by IT professionals and used by business professionals, domain experts and/or citizens. Such web applications have already become indispensable parts of our lives. On the other hand, a lot of routine work is still performed by manual operations although these manual operations for the routine work can be automated by IT. This is because web application development by IT professionals requires a comparative fund.

Primarily, it is preferable for business professionals themselves to support these web applications since web applications must be modified frequently based on users' needs. Therefore, technologies for end-user development have become important for the automation of the routine work.

Terms for end-user computing (EUC) and papers on EUC came out in the 1980s. Some papers described definitions and classifications of EUC (Cotterman et al. 1989), the management of EUC (Brancheau et al. 1993) and summary of the trends of end-user development without IT professionals' assistance (Sutcliffe et al. 2004). End-user software engineering research for end-user programmers and domain experts appeared also (Fischer et al. 2009; Ko et al. 2009). Reference (Scaffidi et al. 2005) estimated that the number of end-users increased in American workplaces and indicated that it was necessary to clarify what end-users are creating with their programming environments and how to improve those tools. Furthermore, reference (Burnett 2012) indicated that it was important to improve software quality in the end-user software engineering area.

Our research target is the technologies that business professionals with domain expertise can definitely define their business rules for their own jobs as requirement specifications which are transformed into executable software without additional description in programming languages. Generally, there are three approaches corresponding to the user interface (UI), business logic (BL) and database (DB) based on the three-tier architecture which has been popular with web applications. In our studies, we considered that end-users are familiar with the UI-driven approach and then developed domain-specific application frameworks based on components. The construction of the graphical user interface and the simple database system was supported by using application framework and visual modeling technologies (Chusho et al. 2011). As for the business logic, however, it is rather difficult to support it in the same way, because there are various kinds of business logic. The applicability of domain-specific application framework for end-user

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development is dependent on how the business logic is expressed. Then, the business logic should be expressed from the view of the service providers or the support systems instead of the view of the clients. Finally it is confirmed that the template based on the UI-driven approach is useful for requirement specifications of business logic.

This paper presents basic approaches for web application development in Section 2, applicability of domain-specific framework in Section 3 and the template for a tradeoff solution in Section 4.

2. BASIC APPROACHES

2.1 Domain-Specific Technologies

Our approach to end-user development is explained in the following layers:

- The business level {Business models}

  << The semantic gap: Domain-specific technologies >>
- The service level {Domain models}

  << The granularity gap: CBSE >>
- The software level {Components}

A business model at the business level is defined by those end-users who are business professionals and domain experts. Then, the domain model at the service level is constructed by the set of the required services as the software requirement specification. At the software level, the domain model is implemented using components. In this approach, the granularity gap between components and the domain model is bridged by CBSE (component-based software engineering) such as business objects (Sinha et al. 2013), patterns and application frameworks. On the other hand, the semantic gap between the domain model and the business model should be bridged by domain-specific technologies with domain knowledge (Sprinkle et al. 2009).

Approaches based on the three-tier architecture are classified into the three categories of UI-driven, model-driven and data-driven processes by first focusing on either the UI (user interface), the model (business logic) or DB. The UI-driven approach has recently emerged as web applications have been increasing sharply. In our UI-driven approach, visual forms were defined first and the framework was used. The business logic dependent on the application was included in form definitions. The other business logic was embedded into the framework. One of the main problems for end-user development is how to describe business logic.

In our studies on domain-specific technologies, the application domains such as the reuse of second-hand articles and lending books or equipment were selected because these domains are familiar to everybody. All of them required at least two DB tables for services. One was for member registration and the other was for object registration. The member implies a system user who may become a provider or a requester of an object. The object is an article, a book, or a piece of equipment. The basic operations are CRUD (create, read, update and delete). For example, a member can register an object, read registered objects, update them or deletes them. Although the columns of a record are dependent on the object, these differences are unified by the concept of "matching" between an object provider and an object requester.

Furthermore, business logic must be different for each application. There are many kinds of applications in the domain of matching services. It is difficult to develop an application framework that can be used for all kinds of matching services because such a framework requires a lot of customization and the merit of easy development of an application is lost. Therefore, it is necessary to focus our research target on a limited subdomain. For this purpose, we analyzed and classified matching services (Chusho et al. 2015). Websites for matching services are characterized by the following three factors:

- WHO : providers and requesters
- WHAT : things and services
- HOW : algorithms for matching decision

For the WHO factor, providers and requesters are limited to ordinary users in our research. Such business activities, such as online shopping and hotel reservations, are not our research target, because the requirements for web applications are too complex. Reuse promotion services supported by local governments, however, are our target because these services are operated at actual counters, instead of websites, and often face a shortage of talents or funds. Our research product will solve this problem effectively. Regarding the WHAT factor, our research targets are things which are reused or are lent, as well as services, such as volunteer work for snow shoveling or the repair of houses damaged by floods. As for the HOW factor, our research target is limited to domains with simple algorithms, and applications with complicated algorithms are omitted, because it is difficult for end-users to define the business logic.

2.2 Web Applications for Matching Service

There are many kinds of matching service sites in practical use and some of them become topics on TV or in articles in the newspapers in recent years in Japan. For example, crowd funding, crowd sourcing, reuse of secondhand articles, rental space, rental cars, real estate sales, special lectures such as English conversation for the Japanese, parking at a residential area, baby sitting and others.

In particular, two typical examples, namely rental rooms at homes, such as Airbnb, and ride-sharing, such as Uber and Lyft, are popular in many countries. Actually, in Japan, these services are considered illegal and limited to some areas which the government admits. The government intends to decide new rules and regulations for promotion of these services. However, groups of hotel managers or taxi drivers request the government to make the rules and regulations severe for fair competition.

Generally, many kinds of matching services become more and more popular as mobile phones have come into wide use recently. Many matching sites can be accessed from the outside or require registration of a photograph of target objects, such as rooms and clothes, because a user can take photographs by using a mobile phone easily. Furthermore, most web services for sharing economy are kinds of matching services.

Primarily, our target for end-user development is different from such matching services supported by IT professionals. For example, local governments support various events for ecological activities such as flea markets, but the effects are limited because of manual operations without IT. Furthermore, when volunteers are requested for natural disaster areas, the local government cannot support the volunteers effectively because of manual operations without IT also.

In order to make our research target clear, the following two criteria were introduced for the analysis of many kinds of matching domains from the viewpoint of the users:

* Request for the trustworthiness of participants
* Request for quality of things or services

These criteria are essential for matching domains. For example, the reuse support service where an article to be reused is given free to a requester by a provider is characterized by <low, low> as values of two criteria in Fig.1. Another reuse support service where an article to be reused is sold to a requester by a provider is characterized by <high, high>. In this case, there may be troubles with payment. Another reuse support service where the requester pays the provider via a website is characterized by <low, high> because the risk of trouble in payment is reduced. Finally, voluntary snow shoveling where a volunteer may visit a house in which an old person lives alone is characterized by <high, low>.

Typical examples of sharing economy may be considered, namely accommodation for travelers and ride-sharing, and the related services. A hotel reservation site is positioned on <low, low> because hotels are trustworthy and the quality of a hotel room is correspondent with the rate. A taxi calling site is positioned on <low, low> also because taxi drivers are trustworthy and the quality of services is assured by taxi companies. On the other hand, sites for rental rooms at home and sites for ride sharing are positioned on <high, high> because the trustworthiness of service providers and the quality of the rental rooms or ride sharing services are not known.

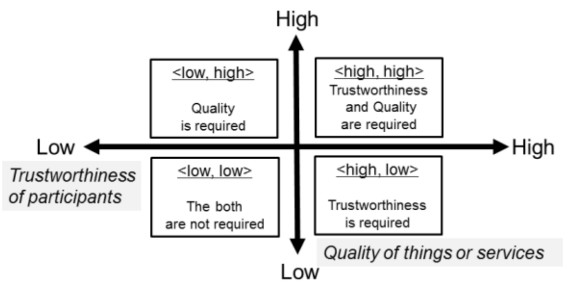

Figure 1. The criteria based on user view

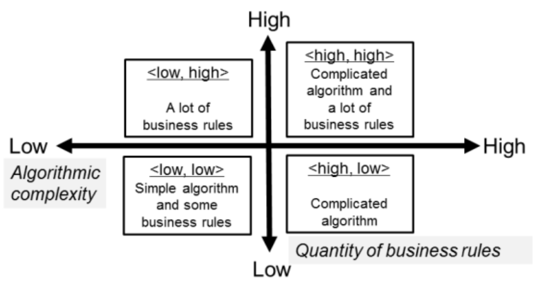

Figure 2. The criteria based on system view

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The classification with these two criteria is based on a user view. The end-user development, however, requires a system view instead of a user view because the success of end-user development depends on whether it is easy for end-users to develop web applications for matching sites. Therefore, the following other two criteria were introduced:

* Algorithmic complexity
* Quantity of business rules

The possibility of end-user development depends on these criteria. If the business logic which the end-users define requires a complicated algorithm, the automatic generation of the corresponding source codes will become difficult. If the number of business rules increase too much, it may be difficult for end-users to define the business logic consistently.

Considering the examples above, the reuse support service where an article to be reused is given free to a requester by a provider is characterized by <low, low> in Fig.2 because the matching algorithm will be simple if the first requester for the registered article obtains the service, and business rules will be a few if the first requester negotiates a detailed procedure for getting the service from the provider directly without mediation of the website. A reuse support service where an article to be reused is sold to a requester by a provider is classified into several categories. Sites belong to <low, low> if the price is fixed, the first requester gets the service and the requester pays the money to the provider directly, without mediation of the website. The matching algorithm will become more difficult if the price is decided at an auction. The business rules will increase if the requester pays the provider via the website.

Voluntary snow shoveling is classified into several categories as well. Sites belong to <low, low> if the number of volunteers are fixed and the volunteers are admitted until the number is filled. The matching algorithm will become more difficult and the business rules will increase if volunteers are registered in advance before volunteers are requested for an actual project, and the volunteers for the project are selected out of the registered members.

Sites for rental rooms at homes are positioned on <low, high>. The matching algorithm is simple because the service requester selects a room from registered objects by himself/herself. However, a lot of business rules should be processed because many kinds of properties of each object are registered and used for searching through the registered objects database. Sites for ride-sharing are positioned on <high, low>. The matching algorithm is complicated because the system must select the service provider which is nearest to the requester.

Consequently, our research target in the system view for end-user development is limited to the <low, low> domain in which the algorithm is simple and there are not too many business rules. The <low, low> domain in the user view is preferable for end-user development, because websites which end-users develop and put into practice do not have the sufficient ability to solve troubles with the trustworthiness of participants and/or the quality of the things or services.

A reuse support system for free articles was selected for the experience with the end-user development as one of web applications which satisfy the requirements mentioned above. This is because it is expected that IT (information technology) contributes to saving resources and environmental preservation for a sustainable society. For example, on a reuse support by a local government, the number of articles and the number of participants will increase if business professionals of the local government develop the application for the web site in which providers can register articles to be reused and requesters can search the list of registered articles for their own use easily.

Recently, volunteer support systems have been selected for the experience with the end-user development as another web application which satisfy the requirements mentioned above. Natural disasters such as great earthquakes, tsunami, floods and mudslides by heavy rain, sometimes strike areas in Japan. At that time, many people want to help refugees as volunteers by clearing the garbage from houses and supporting their lives at places of refuge. These volunteers are not actually dispatched to suitable sites where they are required because the local government must process many kinds of requests through a small staff and the management of volunteers and relief supplies tends to be late. The volunteers could be dispatched quickly to suitable sites and relief supplies could be dealt quickly to the people who need them if the local government staff can develop and operate a web application easily for matching volunteers and sites that require a lot of support, or relief supplies and refugees.

3. APPLICABILITY OF DOMAIN-SPESIFIC FRAMEWORK

We have already tried to develop the technologies for end-user development of web applications which are used for websites. The typical five experiences are shown in Fig. 3. The horizontal axis implies the programming granularity. The granularity is small if the business logic is described in programming language such as Java. On the other hand, the granularity is large if the business logic is described in domain-specific language such as business words. The scripting languages are positioned on the middle. Generally, the description level will tend to the non-programming level as the granularity becomes larger. The vertical axis implies the applicability of the domain-specific framework. Generally, the domain which end-user technologies will be applied to is limited as the applicability becomes lower.

In the first case study in the highest applicability in Fig. 3, a domain-specific framework was developed and applied to the development of a reuse support system (Li et al. 2012). This is a component-based framework. An application is constructed not by programming but by defining the components. The end-user models DB, GUI and the business logic by using visual modeling tool and keeps these results in the JSON model, the CSS model, and the SQL statements. The framework runs applications by interpreting these models.

In the practical modeling process, first, the end-user needs to create three tables for management of members, objects, and requests for registered articles, while defining the name and the data type of each column in the tables. Next, the GUI is defined with the information including the items, item attributes, display style, an input/output, etc. while creating the components by dragging and dropping the elements and setting up the attributes of an element. Then the pages are composed of the components. The functions for the business logic are classified into four categories: {validation, DB operation, page transition or navigation}. For example, the SQL statements for the business logic are generated by setting the reference between the data models and the relationship of the data model and the GUI. These relationships are defined by connection lines between objects.

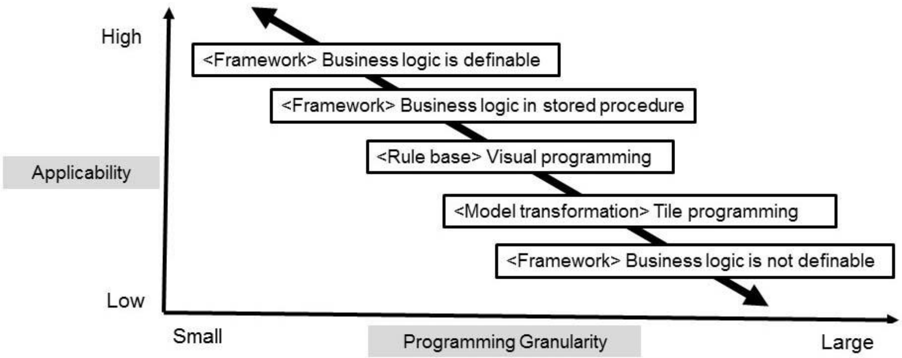

Figure 3. The relation between applicability and programming granularity

In the second case study in Fig. 3, a domain-specific framework was developed and applied to the development of a reuse support system (Xu et al. 2014). The main part of procedures for business logic is included in the database. The functions of the reuse support system were defined as follows: (1) The user registration and modification of the user information, (2) The user identification by using the mail address, (3) The article registration and update of the article information, (4) The search and request for articles, (5) The process for making a decision of the receiver. The system was developed based on ASP.NET MVC model. The DB server was implemented by using the SQL server. The six DB tables were introduced for the information of users, articles, requests for registered articles, the kind of article, methods for passing articles, and management of matching state transition.

Let's consider the following typical rule about article registration:

"If the user has already registered some articles the number of which is the upper limit,
the user cannot register another one."

This rule requires database access and will be processed as follows: (1) The information about the articles registered by the user is retrieved, (2) The number of registered articles is counted, (3) If the number is less than the upper limit, the article is registered, (4) If the number is the upper limit, the article is not registered.

Almost all processes execute database access as this rule does so. Then business logic including this rule is implemented in a stored procedure, instead of using SQL statements. The maintainability is improved for frequent business rule modification. The description of business rules which end-users input by using a visual tool should be transformed into the stored procedures by an automatic code generation tool. The four basic stored procedures {select, insert, update and delete} for each table of a reuse support system are prepared. The other stored procedures are generated by modifying these basic stored procedures.

In the third case study in Fig. 3, a domain-specific rule-based system was developed and applied to the development of a reuse support system (Iiyama et al. 2015). The main part of procedures for business logic is expressed in rules and then transformed into an Android application. It is convenient for a provider of an article to take and register the photograph by using a mobile phone. End-users define business rules of the web applications by embedding the value components in process components and condition components. The condition components are used for construction of the condition part of a business rule. The process components are used for construction of the action parts of a business rule. Some of them are prepared for CRUD operations for DB access. For these rule definitions by using a visual tool, it is necessary for end-users to understand a few programming concepts.

In the fourth case study in Fig. 3, model transformation technologies based on a model-driven approach were developed and business logic of an application system was described with tile programming (Chusho et al. 2011). The model transformation technologies were applied to development of a small-scale library system since this approach is suitable for workflow-centered back-end systems.

A web application model was designed by using the visual modeling tool with a palette of general components. Some pages were defined, namely the top page of the application, the form for the registration of a book, the form for the definition of business logic of the registration of a book, the form for the announcement of completion of the registration of the book, and the form for database manipulation. Tile programming was adopted and then the system prepares some templates for instruction statements. End-users construct the business logic by combining these templates. This model is transformed into the design model under the condition of the particular platform of the Struts 2 framework. In examples of mapping, some of them are as simple as one page being mapped into one JSP document. Others are as complex as the business logic being mapped into Java classes and a Struts.xml document. This transformation program is described in XSLT since both models are stored in XML in the system. The code generation tool generates the source codes for the application which include Java classes with class names, properties and methods, and JSP files. On the other hand, a set of files which is common to web applications, is not included in the design model, and is appended to the source codes by the code generation tool. The web application model is composed of 25 form definitions, 8 business logic definitions and 3 database table definitions. It was confirmed that it was easy for end-users to construct the web application model.

In the fifth case study in Fig. 3, a domain-specific framework was developed and applied to the development of a small-scale library system without complicated business rules (Hashimoto et al. 2012). This framework was developed based on Ruby on Rails since a simple application with basic access to the database was generated by using scaffolding in Rails. The framework provides visual tool with GUI (graphical user interface) for definitions of database tables. DB search functions and validation functions for input data values were added to the framework. Then end-users can select these functions if the applications needs them. On the other hand, end-users cannot define arbitrary business logic since the framework promotes end-user development with a non-programming method.

Consequently, Fig. 3 shows a tradeoff between the applicability of domain-specific frameworks and programming granularity. Then, such process improvement of business logic definition as the applicability becomes higher for the same programming granularity is important for promotion of end-user development.

4. THE TEMPLATE FOR TRADEOFF SOLUTION

4.1 The Template for Business Logic Definition

For considering web application generation process for solutions of the tradeoff problem mentioned above, an application architecture is limited to a typical three-tier architecture. Then, web applications are defined using a business logic definition tool and a CRUD definition tool. Our web application generation process, named the ABC development model, is expressed as follows:

Application = Business logic + CRUD

A web application is defined at the logical level by end-users as follows:

1. The user interface and the DB tables are defined.
2. The business logic is defined based on the above definitions.

The business logic at the requirement specifications level is mapped into the combination of user interfaces (UI), business logic (BL) and databases (DB) based on the typical three-tier architecture. The following template is introduced because the UI-driven approach is suitable for the end-user development:

1. UI: The system gets a request from a client.
2. BL: The system processes the request.
3. DB: The system accesses the database.
4. BL: The system processes the results.
5. UI: The system displays the results.

This template, named UtoU, implies that the typical process is {UI > BL > DB > BL > UI}. It is easy for an end-user to understand this process because the end-user as a business professional or domain expert is familiar with the following typical work flow such as getting a resident's card: (1) A client fills out an application for the card and hands it to the service counter at a city office. (2) A clerk at the service counter checks the application and passes it to a computer operator in the back. (3) The operator inputs the information about the client and gets the resident's card. (4) The clerk receives it and confirms the contents. (5) The clerk finally hands it to the client. Therefore, the UtoU template is considered to contribute to overcoming the tradeoff between the applicability and programming granularity in Fig. 3 because the process of business logic definition is improved as the applicability becomes higher for the same programming granularity. A case study for this process using the UtoU template is described in the next section.

4.2 A Case Study

Recently, volunteer support systems have been selected for the experience with the end-user development. Many people want to help refugees as volunteers, clearing garbage from houses and supporting their lives at places of refuge after a natural disaster. These volunteers are not actually dispatched to suitable sites which require them because the local government must process many kinds of requests through a small staff and the management of volunteers and relief supplies tends to be late. The volunteers could be dispatched quickly to suitable sites if the local government staff could develop and operate a web application for easily matching volunteers with sites that require a lot of support, or relief supplies for refugees.

Therefore, an application framework for a volunteer support system was developed (Yokoi et al. 2015). The design concepts are simple matching algorithms and minimum requirements for practical application development. If a volunteer select a project after the project is registered, the project manager decides quickly whether or not to accept the volunteer. If the project manager selects volunteers from a list of candidates who are registered in advance, the selected volunteer decides quickly whether or not to accept the request. This framework was implemented by using JavaEE and applied to development of a volunteer support system.

Let's consider applying the UtoU template to a definition of registration of volunteers for supporting refugees of a natural disaster. First, the first user interface of the template: { *UI* > BL > DB > BL > UI} is defined by listing all input columns at the logical level as follows: { the identification number of the specified voluntary project, the member identification number, the name of the volunteer, the check box for a declaration of observing the rules on volunteer activities}. Next, the last user interface of the template: { UI > BL > DB > BL >*UI*} is defined by listing all output columns at the logical level as follows: {the name of a volunteer, the identification number of the specified voluntary project, the registration number of the project}. Then, the DB table of the template: { UI > BL > *DB* > BL > UI} is defined by listing all columns of each record at the logical level as follows: { the identification number of the voluntary project, the registration number, the member identification number of the volunteer, the date, the status of "registration" or "rejection" }. Then, the first business logic of the template: { UI > *BL* > DB > BL > UI} is defined by listing checks of input columns and internal processes as follows: { All input columns are filled in; All input data are valid; The identification of the registration date; The confirmation of being not full; The generation of the registration number;}. Finally, the last business logic of the template: { UI > BL > DB > *BL* > UI} is defined by listing all output columns and internal processes as follows: { The name of a volunteer; The identification number of the project; The registration number on the project;}.

5. CONCLUSION

It is preferable for business professionals themselves to support their web applications since web applications must be modified frequently based on users' needs. Therefore, technologies for end-user development have become important for the automation of the routine work. This paper described domain-specific technologies for the end-user development of web applications with the three-tier architecture of the user interface, business logic and database. The matching domain was selected for case studies and analyzed. Then, the applicability of the domain-specific technologies was analyzed. For improving a tradeoff between the applicability and programming granularity, the UtoU template was introduced as the applicability becomes higher for the same programming granularity. After the DB table definitions and GUI definitions, business logic is defined by using the UtoU template. It was confirmed that these technologies are effective for end-user development.

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APPLICATION OF BUSINESS INTELLIGENCE SYSTEM IN COMPANY RESTRUCTURING PROCESS: THE CASE OF CROATIA

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ABSTRACT

After Croatian accession to the EU, Croatian companies have faced tough competition and all other challenges posed by doing business in open markets. These companies must increase competitiveness and take their position on developed globalized markets through differentiation of their products and services and/or creation of cost advantage. For many companies in Croatia this necessitates restructuring of the firm through which a comparative advantage can be achieved. This paper describes the restructuring process and actions which are taken during the restructuring, the goal of which is to increase efficiency and achieve intelligent management of the company. During restructuring process, it is important to apply both qualitative and quantitative approach in business analysis in order to detect key weaknesses and problems. The main tool in business analysis, which is the foundation of making business decisions during restructuring process, is the business intelligence system. Business intelligence systems enable companies to obtain wide-ranging information about factors which influence the business. The presented case study demonstrates specific examples of utilization of business intelligence systems during the restructuring process, synergy of business intelligence, strategy and business processes and improvements achieved through implementation of certain measures during the restructuring process.

KEYWORDS

BI technologies, data warehouse, analytical processing, reengineering, case study

1. INTRODUCTION

The increasing intensity of competition in global markets and the global economic crisis had a negative impact on the profitability of Croatian companies in recent years. There are several reasons, but one of the most important ones is that Croatian products are on the lower level of competitiveness in terms of price and quality compared to products on the international markets. It is therefore of great importance to restructure Croatian companies, ensuring increased competitiveness and business efficiency.

These conditions require management to conduct company restructuring in order to achieve efficiency and every aspect of success. Usage of BI technology and development of business intelligence system have an important role in achieving maximal effects of the company restructuring.

This paper is structured as follows. Following an introduction, in Section II, the Business Intelligence is shortly presented, brief overview and advantage of company restructuring is displayed in Section III, examples of BI system application in the restructuring process is shown in Section IV. Finally, in Section V, the main conclusions are drawn.

2. BUSINESS INTELLIGENCE

Business Intelligence is a set of tools and methods that helps the company to collect internal and external data, converts them to information and based on information creates knowledge. According to Peter Drucker (Drucker, 2003), knowledge has become a key economic resource that is by relevance ahead of the three traditional business resources (labor, capital and land).

Main components of business intelligence as shown in Figure 1 are (Liautaud and Hammond, 2001):

- Data Warehouse,
- ETL process (Extract, Transform and Load),
- Business intelligence platforms.

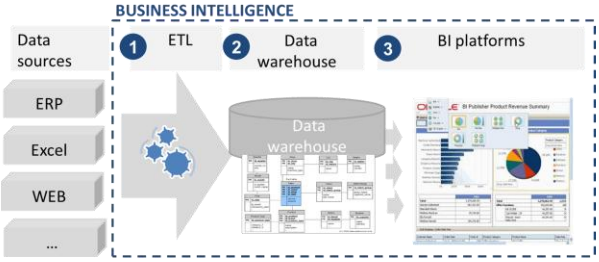

Figure 1. Main components of BI

Each of these components will be further developed below.

2.1 Data Warehouse

Data warehouse is a repository designed to accept data collected from transaction systems, operational data stores, and external sources. Data Warehouse then connects this information in the aggregate, summary form acceptable for analyzing and reporting based on pre-defined business needs (Gartner, 2015). Operational database disables the integration and analysis of data from various modules that significantly complicates the understanding of the entire business and at least a certain part of the process. Due to the limited space in the operational database, it does not contain historical data so it is impossible to conduct an analysis of trends and performance over a longer period of time.

The data warehouse allows us to get integrated data in a short period of time from which we can monitor trends and predict future events. "Decision support system based on the data warehouse concept ensures timely access to quality information as a basis for decision making"(Ćurko, 2001).

A data warehouse is the data base where business data is collected and stored, but also represents a source for information that will later be processed and used in business intelligence reports. The data warehouse should be designed in a way that easily adapts to changes in business, must have the ability to accept new data and changes in the hierarchy and relations among the data. It should include data from all functional parts of the company to meet the information needs of users on the strategic and operational levels. Apart from internal sources, data warehouse can collect structured and unstructured data and information from external sources.

2.2 ETL

The set of processes that are in professional community called ETL process aim to extract, transform and load data from one or more operational databases into the data warehouse (Panian, 2007). ETL starts with the preparations that include conversion, synchronization and data cleansing (Panian and Klepac, 2003). The extraction phase aims to convert the data collected from different sources into a single format appropriate for data transformation. Data conversion is needed to unify the data that will be used in later phase. Synchronization is important in order to avoid data inconsistency when the same attribute in data warehouse has different values. Data cleansing is the process of detecting and deleting corrupt or inaccurate records from a database that could have occurred during testing and simulation.

2.3 Business Intelligence Platforms

Business intelligence platforms are tools that help end users, through processing data, to analyze business, to find out what happened in the past, why a particular business event appeared, to see what is currently happening and to try to predict future events. Figure 2 (Wayne and Eckerson, 2007) presents the tools that are appropriate for each individual need and will be described below.

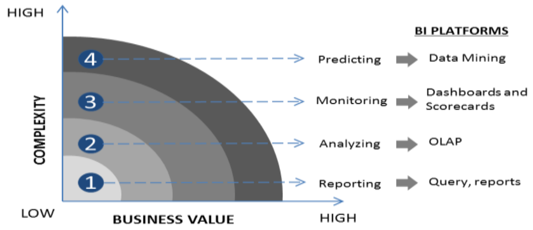

Figure 2. BI platforms (Wayne and Eckerson 2007)

Business Intelligence Reports are predefined reports and ad hoc queries that give the information about events that already occurred.

OLAP is a group of tools for creating information and knowledge out of data and is an acronym for On-Line Analytical Processing. "OLAP is a conceptual and intuitive model based on a multidimensional analysis method, which implies that data can be simultaneously looked at through a larger number of filters, which in technical terms are called dimensions" (Panian, 2007). OLAP involves very robust computing capabilities needed to meet the specific calculation requirements of the multidimensional structure. OLAP tools rely on warehouse or data mart from where they gather information and allow a user to perform rapid analyses that enable managers to ask questions and get answers in a very short time.

Dashboard is a visual display of the most important information needed to achieve one or more objectives that have been consolidated on a single computer screen so it can be monitored at a glance (Few, 2006).

And finally, BI platforms include the data mining capability. "Data mining is the search for valuable information in large volumes of data. Data mining is the exploration and analysis, by automatic or semi-automatic means, of large quantities of data in order to discover the meaningful patterns or rules"(Pejić Bach et al, 2007). Data mining can be interpreted as finding of relationships between variables in large amounts of data in order to discover some behavior patterns that were unrecognized before and to more accurately predict future trends, enabling us to make business decisions based on knowledge.

3. COMPANY RESTRUCTURING

According to data published by the Croatian Bureau of Statistics[1], there was a significant drop in activity of industrial enterprises in Croatia in the last few years. Significant decline in GDP and industrial production was for the first time recorded in 2009. The effects of the global financial crisis which started in 2008, have spilled over into the real sector, and in 2009 the gross domestic products of all economic superpowers such as United States, Japan and the European Union have declined. Although the global economic recovery started already in 2010, Croatian economy has continued to decline until 2015, which has negatively affected Croatian companies that were traditionally more focused on domestic market. To compensate the income loss in Croatia, they had to focus on foreign markets. In addition to the crisis, Croatian accession to the EU had an additional impact on the Croatian industry, which meant that companies had to make greater effort to gain and maintain competitiveness.

In such tough economic environment many companies have had to implement some kind of restructuring, which should help them achieve optimization of operations and cost reduction, thereby ensuring international competitiveness.

3.1 Financial Restructuring

Companies in distress in most cases are facing liquidity and insolvency problems. In order to improve the financial situation of an enterprise, companies go through financial restructuring process. The most important measures which are normally included in restructuring plan are (Pomerleano and Shaw, 2005): debt to equity swap, capital increase, debt write-off, extension of loan maturity and reduction of interest rates.

[1] http://www.dzs.hr/basic indicators

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In September 2012, Croatian Government has adopted Pre-bankruptcy settlement procedure as a legal framework for carrying out the financial restructuring process. The implementation of the financial restructuring has a short-term goal of improving financial stability of the company. However, in order to achieve long-term stability and remove the causes that led to the crisis it is important to carry out operational restructuring too.

3.2 Operational Restructuring

The process of operational restructuring starts with a very detailed analysis of existing conditions and benchmarking. The objective of operational restructuring is a fundamental change in the cost structure in order to achieve the greatest value to the customer at the lowest cost (Zilka, 2010).

More often than not, management becomes aware of the need for the restructuring after significant decline in profitability and liquidity problems. Most companies at this stage are in a state of "unconscious incompetence", they are unaware what they are doing wrong, but to get to the stage of “conscious incompetence” and discover the causes of reduced profitability, we need business intelligence.

Figure 3 (Zilka, 2010) shows the fundamental framework of the operational restructuring. The foundation elements of the restructuring process are: analytics and benchmarking; change management and communication; and governance and knowledge management.

At the core of the model are data, analytics, and benchmarking. The best way to find out which parts of the process are inefficient and non-optimized is to compare parts of business processes and performance metrics to industry leaders and best practices from other companies.

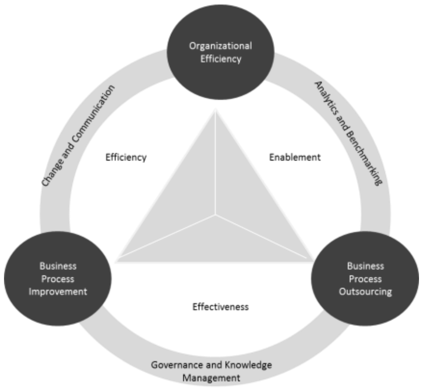

Figure 3. Holistic Framework (Zilka, 2010)

Application of these methods can help detect business segments that are performing well and other segments that have to be improved.

The restructuring process implies the implementation of changes in business. It is important to communicate the changes with employees and explain the reasons for the implementation so they can except and execute changes.

The project team involved in the restructuring process must include highly qualified employees from all segments of the company. The project team, through the process of restructuring, is building a knowledge management system, which increases the level of knowledge in the company and is supplying employees with the information relevant to the business. Members of the project team, after the changes are implemented, train employees on how to utilize the new and improved processes, tools, and technology in order to successfully implement changes.

The framework consists of three separate and distinct work streams: organizational efficiency, business process improvement and business process outsourcing.

The goal of reorganization is to modify the current structure in order to meet its objectives more effectively, while transformation includes fundamental change in the structure itself and in the organizational culture of the company (Sikavica and Novak, 1999).

A process can be viewed as a set of activities performed utilizing human resources, technology and information to get to the final product. Business process improvement (BPI) is a set of disciplines and tools applied by managers to improve company performance (Improving Business Processes, 2010; Khan, R. N., 2004). BPI focuses on introducing drastic and fundamental changes to business processes with the aim of increasing efficiency. Companies and managers usually use process maps to define all the process activities and the process workflow. Companies with developed business intelligence systems regularly monitor the performance of each process, as well as measure the success and the level of input and output of different process segments. In defining a process map, each process step is explained in detail, including a description, number of repetitions, responsible person and time required for completion. In this phase, a proposal for process redesign, which would ensure quality output and fulfillment of customer expectations at the lowest possible cost and within the shortest possible period of time is prepared. Through process redesign, the number of duplicate tasks, causing unnecessary utilization of resources, is reduced. Process steps that are independent from others are outsourced, and certain activities are proposed to be performed simultaneously in order to reduce time required for process completion. The ultimate goal is to establish a system for monitoring business process steps using business intelligence systems to enable simple monitoring and bottleneck detection in the future.

Outsourcing of business processes or activities (Bahtijarević Šiber and Sikavica, 2001) is an organization's decision to stop an activity that is more successfully performed by the competition, which is usually connected with the organization through a network. Organizations thus focus on their main activities and outsource the activities which they perform less successfully than the competition. The decision to outsource an activity relies mainly on the fact that external sources (sources operating outside the organization) perform particular activities more efficiently and at a lower cost compared to the organization. The decision to apply outsourcing as a business strategy must be preceded by a thorough analysis of the organization's condition, taking into consideration all its structural elements. A detailed analysis of the costs of each process considered for outsourcing is performed. The results are then compared to the costs that would be incurred through outsourcing.

Goals that need to be achieved through the process of operational restructuring: a) efficiency, b) effectiveness, and c) enablement. Through restructuring process, we want to enable company to do the right things in efficient way.

4. EXAMPLES OF BI SYSTEM APLICATION IN THE RESTRUCTURING PROCESS

The company which constitutes the subject matter of the case study initially had a partially developed business intelligence system, which was upgraded in the restructuring process to suit the company's business needs. An important segment of any business intelligence system is a profitability monitoring system. Depending on the activities that it performs, a company's profitability can be analyzed taking into consideration the three main business segments, i.e. production, engineering and logistics.

4.1 Production

The goal of any company is to allocate as many costs as possible to product units in order to determine which types of products or services are most profitable, i.e. which products or services contribute most to the coverage of costs and should be focused on in order to achieve the highest possible earnings. It is sometimes extremely difficult to do so as some of the costs may not be allocated to a particular product or are allocated based on the estimated utilization of particular resources (e.g. depreciation of machinery, power, and similar). The more precise the cost allocation, the more realistic the view of the company's business operations, e.g. the average profitability by product, market, and similar. Business intelligence systems are the most important tools for deriving such information. Since the analyzed company used data from two different sources in its Production Business Unit, i.e. a production process information system developed for company purposes and a warehousing and sales module built into the transaction system purchased and adjusted to the company's business needs, application of a business intelligence system proved necessary to integrate such data. Prior to integration of production and sales data into a data warehouse, it was quite difficult to monitor the actual profitability since one source included data on utilization of raw material, hours of work, power, etc., while the other included data on realized revenues by product category, and the data were not unified.

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Profitability used to be monitored by taking into consideration the calculative price (estimated) and not the actually booked costs per work order. This was quite misleading in cases where calculative prices were significantly different from the realized costs. Figure 4 presents the process of integrating sources and data, which enables profitability monitoring by product and customer.

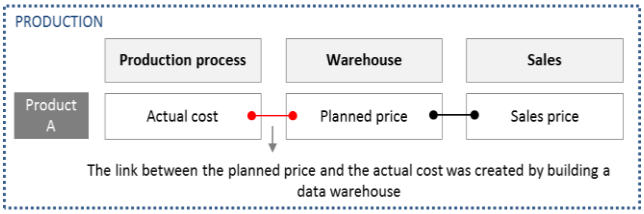

Figure 4. Connecting data in Production module

This monitoring method is significant as it allows comparison of prices with the competition as well as determination of margins achieved by particular product category. In case the margins fall below average, the company can identify the categories and production processes that are less profitable and start implementing measures to improve and reengineer certain business processes in its Production Business Unit.

4.2 Logistic

In the analyzed company, logistics used to be merely a support activity performed within the Construction and Production Business Units. The largest part of logistic activities referred to transportation of goods and use of specialized vehicles as tools for on-site construction works. The existing transaction system provided very little information on performance of the Transportation Business Unit, which made any analysis impossible. The services were billed applying the prices based on estimated costs per vehicle category, but the comparison of revenues and actual expenses was possible only at the aggregate level of revenues and expenses of the Transportation Business Unit. The company's business intelligence system was later upgraded to include the possibility of collecting the following additional information for each vehicle, thus enabling analysis of company performance and comparison of prices with the competition: start and end point of each trip, realized mileage per trip, quantity of freight which is being transported and vehicle utilization in days per year.

The costs are allocated at the level of particular vehicles. After collecting the above mentioned data, it is possible to make analyses and obtain answers to the following questions:

- To what extent is a particular vehicle utilized during a period of one year (in days and kilometers)?
- What is the average weight of the freight being transported?
- What is the share of fixed costs in the total costs per vehicle?

The analysis showed that the vehicles used to transport goods were insufficiently utilized and that the average realized mileage per year was very low, which is why the share of fixed costs (depreciation of vehicles, cost of maintenance, driver salaries, etc.) was high in terms of unit prices. An additional disadvantage determined through the analysis is the fact that the vehicles usually return empty and the return trip is therefore not charged for. This is due to the fact that the company is not registered for performing transportation services. It transports goods for own purposes only, which makes it very difficult to fill the capacities during the return trip. Service providers specialized in transportation usually manage to fill the capacities and record a smaller share of unutilized trips due to a large number of customers. The analysis results show that multiple financial benefits would be achieved if the company outsourced transportation services, and considering that transportation services do not constitute part of the company's main activity and that there are numerous external providers of such services, the company's operations would not be jeopardized through transportation outsourcing.

4.3 Engineering

The Engineering Business Unit is responsible for construction works and the related activities, such as contracting of projects, monitoring of project realization, supply of goods, coordination of logistic services, coordination of employee activities, etc. The data required to monitor the projects and activities of the

Engineering Business Unit were stored in different sources. It was necessary to integrate the data and create new databases which would include other information concerning the company's business operations that were not previously monitored. Further in the text is a list of data relevant for monitoring and planning the activities of the Engineering Business Unit (also indicating the relevant source):

Project Realization (Accounting / source – Oracle E-Business Suit): detailed presentation of realized revenues and expenses, claims, liabilities, collected amounts, realized hours of work, etc.;

Project plan (Project Management / source – a template in Excel for each particular project from which the data are automatically transferred to the data warehouse): planned future monthly revenues and expenses, planned project cash flow, planned utilization of human resources, required bank guarantees, etc.;

Bank guarantees (Finance / source – a template in Excel for each particular project from which the data are automatically transferred to the data warehouse): data on the total and utilized guarantee amount, maturity by bank guarantee and name of project that it refers to;

Future projects (Contracting / source – a template in Excel for each particular project from which the data are automatically transferred to the data warehouse): list of all future projects/tenders the company could apply for and, as a result, potentially contract new jobs, including the data concerning the approximate margin, required guarantees, required human resources, etc.

Integration of realized and planned data on existing projects allows us to compare the margin realized up to the current project stage, the target margin, as well as to estimate the company's financial results and cash flow. Cash flow estimation is one of the most important financial statements. Where there are a few dozen or hundred projects the realization of which and the related plan can change often during the year, we need a tool for collecting and aggregating such data, as well as for integrating them with other data relevant for cash flow estimation (existing monies due to suppliers, liabilities under loans, etc.).

Considering that it is very significant for the analyzed company to manage its limited resources (human resources, guarantee amount, equipment, etc.) efficiently, answers to the following questions must be obtained in order to maximize profit:

- To what extent is the total guarantee amount utilized currently and when is the release of the guarantee limit expected so that new contracts could be contracted?
- What share of human resources is being utilized on current projects and what is the expected future utilization of human resources on currently contracted projects?
- What kind of projects are expected in the future?
- What are the estimated earnings that could be achieved on future projects and markets?
- If we take into consideration the limited total guarantee amount and the limited human resources, how many new projects could be contracted and in which markets in order to maximize profit and simultaneously ensure optimum capacity utilization?

By integrating data from different sources, as described above, we get a clearer insight into the company's business operations, recognize its strengths, identify its weaknesses and start implementing appropriate standard restructuring activities in order to implement improvements and eliminate the causes that put the company in a crisis.

5. CONCLUSION

BI systems and data warehousing capabilities allow collection of all data relevant for business operations and a quick and easy access to data turn in to information required for analysis. All companies analyze particular standard financial data for business performance monitoring purposes. It is however important to recognize the specifics applicable to a particular company which are relevant for its management process. This is very important in determining the design and architecture of the business intelligence system, which is why communication between top management and departments involved in business intelligence system development, is extremely important.

In this paper we show a profitability monitoring system, as an important segment of upgraded BI system and how can help it in production, logistics and engineering restructuring process.

The goal of any production company is to allocate as many costs as possible to product units in order to determine which types of products are most profitable. Through data integration from production, warehouse and sales, BI system enables profitability monitoring by product and customer and the company can identify

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the categories and production processes that are less profitable and start implementing measures to improve and reengineer certain business processes in its Production Business Unit.

The largest and most important part of logistic is Transportation Business Unit. The company's BI system integrated data for each vehicle such as: start and end point of each trip, realized mileage per trip, quantity of freight which is being transported and vehicle utilization in days per year, thus enabling analysis of company performance and comparison of prices with the competition. By using BI system information and analysis show that multiple financial benefits would be achieved if the company outsourced transportation services

The Engineering Business Unit is responsible for construction works. It was necessary to integrate the data from different sources (accounting, finance, etc.) such as: project realization, project plan, bank guarantees and future projects, required to monitor and planning the projects and activities. Integration of realized and planned data on existing projects allows company to compare the margin realized up to the current project stage, the target margin, as well as to estimate the company's financial results and cash flow. Where there are a hundred projects the realization of which and the related plan can change often during the year, company desperately needs a system for collecting, aggregating and analysis such data to manage its limited resources efficiently.

The management asks questions every day. They require answers in order to make business decisions. The role of the team responsible for business intelligence system development is to create data collection and integration platforms (with other data contained in the warehouse), and provide the relevant information for relevant answers in the form of reports.

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METHOD TO IDENTIFY DEEP CASES BASED ON RELATIONSHIPS BETWEEN NOUNS, VERBS, AND PARTICLES

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ABSTRACT

Deep cases representing the significant meaning of nouns in sentences play a crucial role in semantic analysis. However, a case tends to be manually identified because it requires understanding the meaning and relationships of words. To address this problem, we propose a method to predict deep cases by analyzing the relationship between nouns, verbs, and supplemental words, such as particles, in Japanese sentences. We also propose new deep cases based on a verb thesaurus and a deep case prediction method using a neural network.

KEYWORDS

Deep case; Case grammar; Text mining; Neural network; Clustering

1. INTRODUCTION

Cases represent the relationships between nouns and verbs in a sentence in Japanese. There are 2 types of cases, i.e., surface and deep cases. Surface cases classify noun roles obtained by the postpositional particle (particle), such as *ga*, *wo*, *ni*, *kara*, and *de*. Particles are similar to prepositions in English sentences. Typically, a particle is often located after a noun. Deep cases express the roles of words in a sentence (Ito, 2002, pp. 101-110). For example, in the sentence, *Tokyo-de asobu (play), de* is a particle denoting a surface case and its corresponding deep case is *location*. The deep case is important in sentence analysis because it reveals patterns of semantic relationships, which is difficult to accomplish with surface cases.

Semantic analysis of sentences is widely applied in many fields, such as machine translation and question answering. Therefore, automated semantic understanding is necessary for effective semantic analysis. However, cases tend to be manually identified because understanding the meaning and relationships of words is difficult for computer programs.

Shibuki et al. (2003) proposed a method to identify deep cases in sentences comprising a verb and 2 nouns (pp. 91-92). They reported a precision of 75.4%. Although some surface cases have corresponding deep cases, many surface cases, such as *ni, de,* and *wo*, can correspond to multiple deep cases (Shibuki et al., 2006, pp. 1413-1428). Takeno et al. (2014) proposed a method to identify deep cases that correspond to the *ni* case (pp. 1011-1014) and reported a precision of approximately 62%. However, it should be possible to apply deep case identification to any sentence because a sentence comprises an unspecified number of nouns and verbs. Moreover, to utilize such identification in natural language processing, generalization of deep case identification for all surface cases is required.

In our previous research (Ide and Kimura, 2016, p. 42), we proposed a method to identify the roles of particles considering the diverse correspondences between particles and their roles based on a previous study (Kimura, 2015, pp. 409-414). Moreover, we extracted relationships between each obtained role and deep cases proposed by Fillmore (1969).

In this study, based on a verb thesaurus (Inui et al., 2010), we define new deep cases wherein surface cases and deep cases are assigned to sentences and extract their characteristics. Furthermore, we propose a method using a neural network to identify the proposed deep cases of a target noun phrase (a noun followed by a particle) from the relationships between nouns, particles, and verbs based on the extracted characteristics. To apply this method to any sentence, we use a combination of a noun, particle, and verb, which is a minimum set carrying the meaning of the sentences.

2. PROPOSED METHOD

2.1 Classification of Deep Cases

A verb thesaurus has multiple fields such as verbs, nouns, particles, surface cases, and deep cases. In particular, many deep cases appear in the deep case field. In our previous study, we examined the relationships between particles and deep cases and found that deep cases can be partially identified by the particle (or the surface cases). Based on this idea, in this study, we classify deep cases in advance and identify new classified deep cases.

For example, the deep case *start point* is assigned to the noun *yane* (roof) in the sentence *yane* (roof)-*kara* (from) *ochiru* (fall down) and *before the change* is assigned to *Osaka*, a large city in Japan, in the sentence *Osaka*-*kara* (from) *itensuru* (transfer). Both sentences whose nouns refer to locations and verbs express movements have a similar meaning. Therefore, the deep cases of both sentences can be unified as a single deep case.

To extract the relationship between the surface cases and the deep cases in the verb thesaurus, we counted their co-occurrence frequency. Then, to classify the deep cases, we applied a hierarchical clustering algorithm to a deep case vector whose elements are the relative frequencies of surface cases appearing in target sentences in the verb thesaurus. Finally, we obtained new deep cases based on the characteristics of each cluster. We employed the *Ward method* to measure the distance between clusters.

2.2 Identification of Deep Cases

In some sentences, deep cases cannot be uniquely identified. For example, in the sentence *kuko* (airports)-*wo* (from and to) *hattyakusuru* (shuttle), *kuko* (airports) can be assigned to both start-point and end-point deep cases. To identify deep cases for such sentences, we employed a neural network to calculate the degrees of assignments to each deep case.

We used the flags of the deep cases as outputs of the neural network, as shown in Figure 1. After training, it was expected that we would obtain a continuous assignment degree value in the range [0, 1] for each deep case as the output of the neural network. Table 1 provides an example of the neural network output and lists each output value and its rank in descending order. In this example, deep case 2 obtained the highest degree and deep case 1 obtained the second highest degree. If multiple deep cases have high values, both can be assigned. In this study, we restricted the assignable number of deep cases to 2.

Numeric values were assigned to nouns, verbs, and particles. These values were used as input for the neural network. Similar to the output, noun, verb, and particle flags were used to obtain the numeric values. However, assigning a flag to each word is not desirable because compared to particles, there are many more similar noun/verb types. For example, consider the sentences *Tokyo he iku* (I will go to Tokyo) and *Osaka ni shuppatsusuru* (I will depart to Osaka). Obviously, *Tokyo* and *Osaka* are place names, i.e., nouns, and *iku* (go) and *shuppatusuru* (depart) are verbs expressing movement. Even though the words are not the same, the difference does not affect the assignment of deep cases to the nouns in the sentences. Thus, we must classify the nouns and verbs based on thesauruses in advance. The neural network input is illustrated in Figure 2.

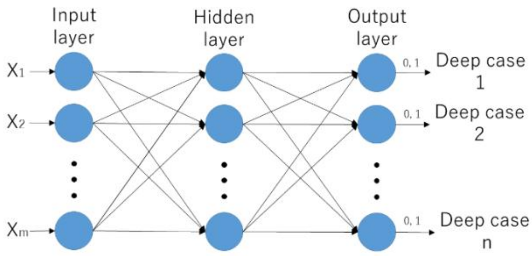

Figure 1. Neural Network Output

Table 1. Examples of Neural Network Output

Output	Output values	Descending order
Deep case 1	0.40	2
Deep case 2	0.70	1
…	…	…
Deep case n	0.03	N

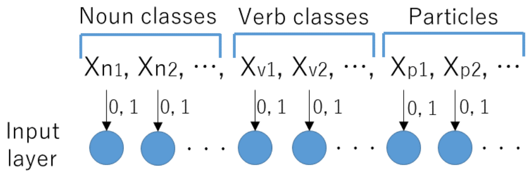

Figure 2. Neural Network Input

3. EVALUATION

3.1 Classification of Deep Cases

We extracted the frequency of surface cases corresponding to each deep case from the verb thesaurus and created a vector whose elements are their relative frequencies.

To organize the data, we unified the variants of expressions, such as reversed particles, e.g., *to-ni* and *ni-to*, in the surface case fields of the verb thesaurus.

The deep case categories were too granular; therefore, we unified obviously similar categories. For example, since *target (person)*, *target (biological)*, and *target (body part)* appeared in the deep case field, we unified them as *target*.

The dendrogram obtained via hierarchical clustering analysis applied to the frequency vectors is shown in Figure 3.

We set the cut-off threshold $\theta = 1$ to separate clusters and assigned numbers to clusters from left to right.

To extract the characteristics of each cluster, we extracted frequent nouns, verbs, and particles in deep cases classified to each cluster. We employed the database of classification vocabulary (DOCV) (National Institute for Japanese Language and Linguistics, 2004) and the verb thesaurus to classify the meaning of each noun and verb.

The frequent surface cases, verb classes, and noun classes of each cluster are shown in Tables 2, 3, and 4, respectively.

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In Table 2, we find that the *ni*, *ga*, and *de* cases appear in multiple (but specific) clusters; however, the *kara*, *to*, *he*, *made*, and *ha* cases appear in only 1 cluster. Therefore, we can say that the surface and deep cases tend to demonstrate a relationship.

Table 3 shows that *position change* appears in multiple clusters and that *relationship* appears only in Cluster 7.

In Table 4, noun classes representing people appear in Clusters 5 and 7 and those representing location appear in Cluster 2.

Based on these observations, we summarize the characteristics of each cluster as follows:

- Cluster 1 represents the end point in action or state changes because it includes many particles, such as *ni*, *he*, and *made*, and verb classes that represent the changes.
- Cluster 2 represents the situation in action or state changes because it includes many noun classes representing locations and deep cases, such as time, location, and situation.
- Cluster 3 represents the affected thing in action or state changes because it includes many *wo* particles and the target of the deep case.
- Cluster 4 represents the means in action or state changes because it includes many noun classes, such as tool, material, and substance, and deep cases, such as tool and means.
- Cluster 5 represents the agent in action or state changes because it includes many noun classes representing the person and particles, such as *ga* and *ha*.
- Cluster 6 represents the original state in action or state changes because it includes many *kara* particles and deep cases, such as the start point and the original state.
- Cluster 7 represents the thing related to the target in action or state changes because it includes many verb classes representing relationship and deep cases, such as mutual and joint.

Based on these characteristics, we defined 7 deep case types: *Start point*, *End point*, *Situation*, *Target*, *Relationship*, *Agent*, and *Tool*.

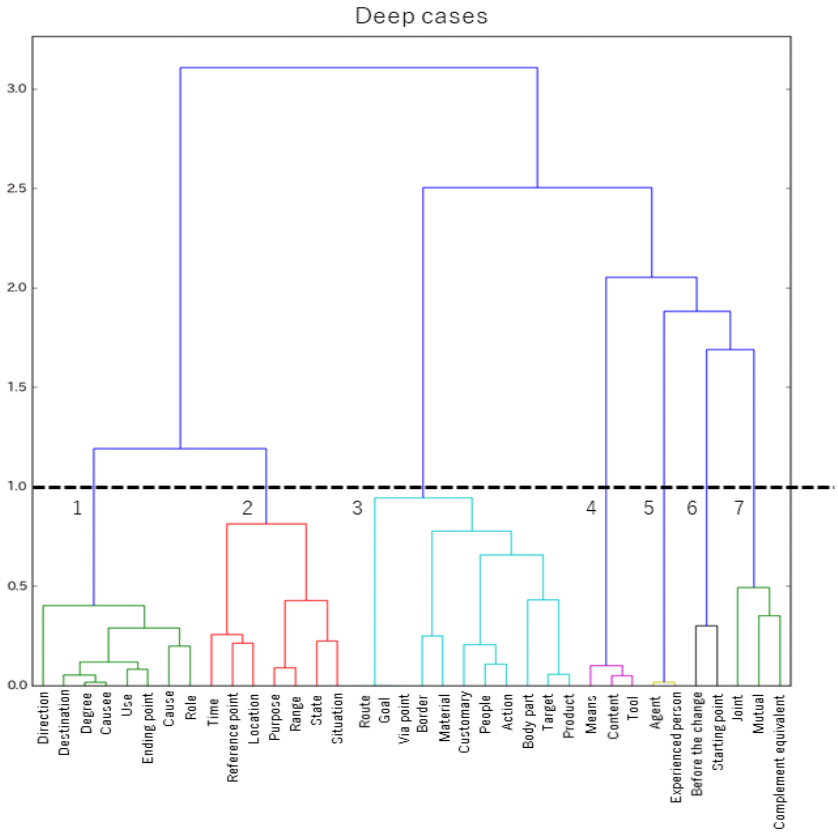

Figure 3. Deep Case Classification Results

Table 2. Frequent Surface Cases of Each Cluster

Cluster	Frequent surface case
1	*Ni, Ni–He, and Ni–Made*
2	*Ni, Wo, and De*
3	*Wo, Ga, and Ni*
4	*De and Ni*
5	*Ga, Ga–To, and Ha*
6	*Kara, Wo–Kara, Wo, and Ni–Kara*
7	*To, Ni, and Ni–To*

Table 3. Frequent verb classes of each cluster

Cluster	Frequent verb classes
1	Position change, Change of agent, Change of target, and Action of encourage the behavior to others
2	Creation–Annihilation, Moving action, Location, Physical behavior
3	Position change, Change of agent, Change of target, and Creation–Annihilation
4	Position change and Change in relationship
5	Position change, Change of agent, Creation–Annihilation, Action to person-object, Physical behavior, and Change of relationship
6	Position change and Change of agent
7	Change in relationship, Relationship with the other, Relationship, and Co-action

Table 4. Frequent noun classes of each cluster

Cluster	Frequent noun classes
1	Unregistered word, Members, Society, Housing, and Public and private
2	Unregistered word, Space, Society, Public and private, Residential, and Heaven and Earth
3	Unregistered word, Mind, Language, Volume, Body, and Life
4	Unregistered word, Tools, Substance, Materials, and Language
5	Members, Human, Family, Unregistered word, and Person
6	Unregistered word, Society, Housing, Space, Public and private, and Members
7	Members, Unregistered word, Companion, Family, and Human

3.2 Deep Case Identification

We evaluated the deep case identification of nouns using the proposed neural network.

We employed the DOCV and the verb thesaurus to classify the meanings of verbs and nouns. In addition, we prepared 5000 training data for each deep case. We oversampled the data for deep cases with fewer sample nouns, except for the nouns not registered in the DOCV. The number of original data for each deep case was 252 *Start point* data, 1427 *End point* data, 213 *Situation* data, 5442 *Target* data, 315 *Relationship* data, 3134 *Agent* data, and 77 *Tool* data.

We set 43 noun classes, 45 verb classes, and 12 particles as the inputs to our neural network, 7 neurons as a hidden layer (sigmoid layer), and 7 deep cases as outputs (linear layer). We used 35000 training data and trained by back propagation.

For evaluation, we calculated the precision of deep case identification with the neural network. The test data comprised 10860 samples, including 288 nouns in *Start point*, 1404 in *End point*, 213 in *Situation*, 5476 in *Target*, 289 in *Relationship*, 3096 in *Agent*, and 94 in *Tool*. We also calculated the precision of a deep case with the second highest output value for samples that were incorrectly identified, which comprised 1408 data, including 22 in *Start point*, 118 in *End point*, 59 in *Situation*, 989 in *Target*, 30 in *Relationship*, 176 in *Agent*, and 14 in *Tool*. The results are shown in Figure 4. The left bars in the graph show the precision of the deep

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case with the highest output value, whereas the right bars show the precision with the second highest output value.

In each deep case, the precisions were 92.4% for *Start point*, 91.6% for *End point*, 72.3% for *Situation*, 82.0% for *Target*, 89.6% for *Relationship*, 94.3% for *Agent*, and 85.1% for *Tool*. The precisions with the second highest output were greater than 90% compared to the test data that was incorrectly identified for the deep case other than *Agent* and *Target*.

It is evident that *Agent* and *Target* achieved high precision. This could be because the neural network was well trained for them since the number of original training data was sufficiently large.

Situation (shortest left bar in Figure 4) also has the shortest right bar whose precision was 21.6%. The features could not be obtained easily because all frequent surface cases in *Situation* also appeared in other deep cases, as shown summarized Table 2. In addition, the neural network could not be trained sufficiently because there were too few training data.

However, the overall precision of the neural network was up to 87%, which is higher than the respective precisions reported in previous studies (75.4% and 62.0%) (Shibuki et al., 2003; Takeno et al.,2014).

Then, to observe the effect of the role of noun classes, we used data that included nouns that are not registered in the DOCV. We evaluated the neural network with 2115 test data, including 70 in *Start point*, 331 in *End point*, 65 in *Situation*, 935 in *Target*, 102 in *Relationship*, 589 in *Agent*, and 23 in *Tool*. To input the noun values, we set all flags to 0. Again, we calculated precision for deep cases with the second highest output value for 516 test data, including 17 in *Start point*, 22 in *End point*, 31 in *Situation*, 185 in *Target*, 12 in *Relationship*, 242 in *Agent*, and 7 in *Tool*.

The results are shown in Figure 5. The precisions of *Target*, *End point*, and *Relationship* are close to those shown in Figure 4. Therefore, their deep cases are less affected by nouns because they can be identified only by a set of particles and verbs. The *Relationship* deep cases can be identified independent of the nouns because there are specific particles and verbs paired to *Relationship*, as summarized in in Tables 2 and 3.

In contrast, *Agent*, *Start point*, and *Situation* were significantly affected by nouns because their precision greatly decreased compared to the results shown in Figure 4. However, their precisions for the deep case of the second highest output value increased. This suggests that although it is difficult to correctly identify the deep cases without nouns, we can the limit candidates of a correct deep case.

These results suggest that we can apply the proposed neural network to identify the deep cases of pronouns.

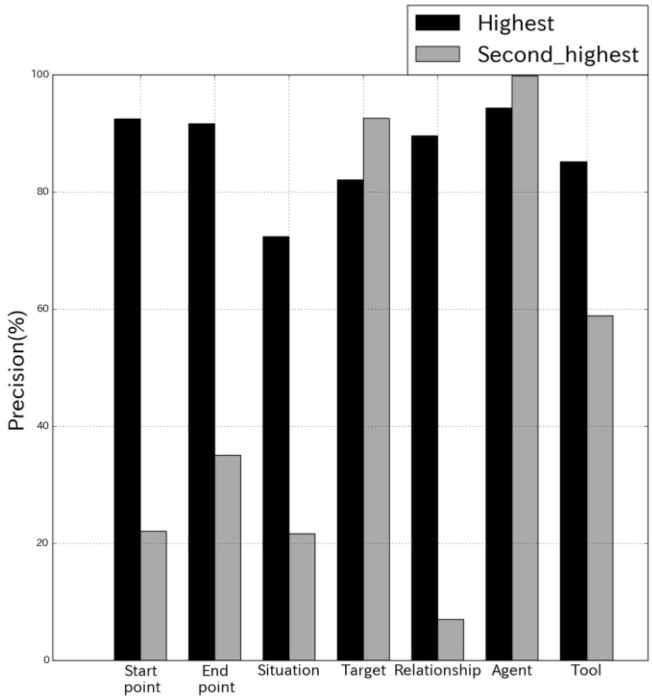

Figure 4. Precisions of neural network obtained with all training data

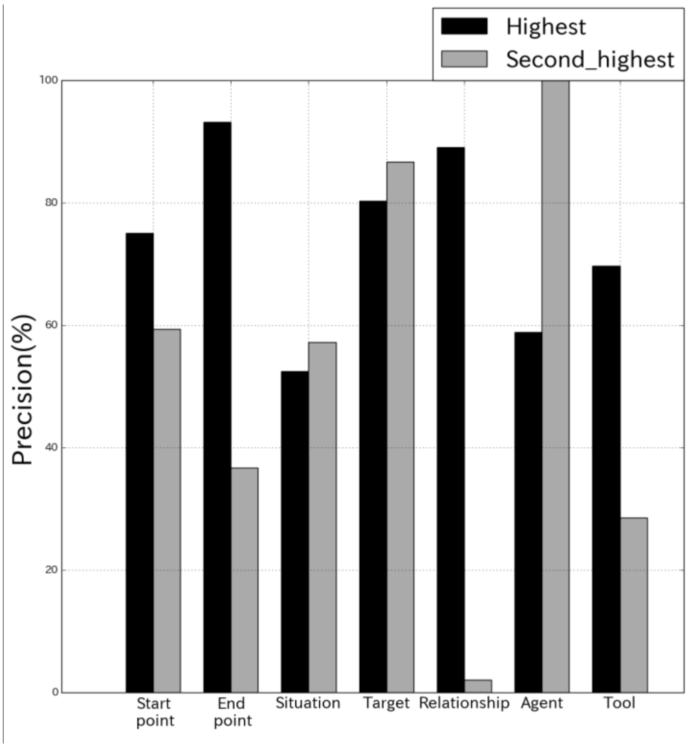

Figure 5. Precisions of neural network obtained using training data with unregistered nouns

4. CONCLUSION

In this study, we proposed a method to identify deep cases from the relationship between nouns, verbs, and particles in order to mitigate the problem by which deep cases are required to be manually identified.

We classified deep cases based on the co-occurrence frequency between the deep cases and surface cases in a verb thesaurus by applying a hierarchical clustering algorithm, and we have defined 7 new deep case types: *Start point*, *End point*, *Situation*, *Target*, *Relationship*, *Agent*, and *Tool*.

Then, to identify the proposed deep cases for sentences, we employed a neural network to calculate the degrees of assignments to each deep case. We used the flags of noun classes, verb classes, and particles as input to the neural network and flags of the proposed deep cases as output of the neural network, and we evaluated the trained neural network using test data.

For each deep case, the precisions were 92.4% for *Start point*, 91.6% for *End point*, 72.3% for *Situation*, 82.0% for *Target*, 89.6% for *Relationship*, 94.3% for *Agent*, and 85.1% for *Tool*. The overall precision of the neural network was up to 87%. The precisions with the second highest output were greater than 90% compared to test data that were incorrectly identified for the deep case other than *Agent* and *Target*. *Target*, *End point*, and *Relationship* were less affected by nouns. In contrast, *Agent*, *Start point*, and *Situation* were significantly affected by nouns.

In the future, we will increase the volume of training data to improve the precision of the neural network and plan to extend a method to estimate omitted words, such as pronouns or zero pronouns, based on the deep cases identified in this study.

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LEVERAGING DATA ANALYSIS FOR DOMAIN EXPERTS: AN EMBEDDABLE FRAMEWORK FOR BASIC DATA SCIENCE TASKS

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ABSTRACT

In this paper, we describe a framework for data analysis that can be embedded into a base application. Since it is important to analyze the data directly inside the application where the data is entered, a tool that allows the scientists to easily work with their data, supports and motivates the execution of further analysis of their data, which would lead to new and interesting findings is desirable. If the analysis process is too complicated, tedious or not apparent, this could restrict scientists, especially in non-IT-related disciplines, from analyzing the data in depth. To enable this solution we first describe the requirements for an analysis tool and explain the steps we took to meet those requirements. Then we describe the steps that are necessary to integrate the analysis into a base application. We also explain how the analysis framework can be extended with new specific components that allow the users to add exactly the features they need for their analysis.

KEYWORDS

Data Analysis, Embeddable Framework, Information Management, Knowledge Management, Modular

1. INTRODUCTION

In a database application for scientific data, the accessibility to analysis of existing data is as important as the ease of correct input. Collecting and analyzing data is the most important part of scientific work, but often scientists require a high degree of time and patience to learn, evaluate, and validate an external tool. This effort drains research resources and creates work. Scientists working in areas that are not related to IT technologies often do not have the motivation and the resources to get familiar with external applications. A build-in tool would provide the needed data analysis features relevant for these scientific areas.

Therefore, exporting data into a spreadsheet (like Microsoft Excel, LibreOffice Calc, etc.) or CSV file and importing this into a separate analysis tool, can in the worst hinder them completely from analyzing the data, since the process may be too complex, time consuming, or error-prone. Also generating the analysis directly in a spreadsheet is not always possible, since complex analyses might require additional functions that are not provided by a generic spreadsheet application, and cannot easily be added without programming skills. Clearly, the process of the data analysis should be easier for the researcher. The best case would be if the feature to analyze the data is already built into the application, where all data is stored and new entries can be added, because the scientist using the build-in application is already accustomed to this working environment.

But even if the analysis tools are built into the application, a crucial problem still remains: The scientists, who are carrying out the analysis, are often not responsible for creating the analysis tools, nor are they even involved in the process of creating them. Not all variations of analysis can be known beforehand since there are often tasks specifically dependent on the scientific work. So the domain experts must be able to create exactly the analyses they require.

To allow this, the application must provide not only predefined analysis methods, but also offer dynamic generation of analysis by chaining together different, simple and configurable modules. However, some scientific tasks are so special that these modules are not sufficient. Therefore, there must be a way to add own, specific modules as well.

In this paper, we provide a dynamic framework for data analysis that can be embedded and thus can be used in different applications. The framework must be extendible, easy to integrate into an existing application, and provide multiple operations that are necessary to analyze data. The framework must be flexible and easy to be used by scientists that are not willing to get familiar with external technologies, to support them in their work.

In summary, the main contribution is as follows: We list a set of requirements that should be addressed by an embeddable framework for scientific data analysis. Then we describe the data structure, the functionality of the modules, and the classification that describes the values in the database. We describe the integration of the framework to another base application and the definition of new, custom modules. Finally we introduce some of the most common modules as examples and use them to present an example of a workflow.

2. REQUIREMENTS

Allowing the users to generate their own analyses out of arbitrary data brings the challenge, that neither the input, nor the output is known. Also all steps in between are up to the users. Still, the users must be able to work in a responsive environment, which allows them to carry out the steps they want and need. But at the same time, not all operations should be allowed, or are possible in a given step of the analysis pipeline.

As a consequence, we have defined several requirements that have to be met to allow a dynamic generation of analyses.

– **Dynamic data structure:** We need a data structure, that allows data to be easily added, removed, merged, and accessed, since the data must be generated, transformed, searched in, and of course, also be displayed. This data structure must also be usable in every part of the analyses, independent of the previous steps.
– **Modular components**: Since the users will define the operational steps, the order in which specific tasks are run is not known beforehand. Therefore we need modular components, that can be linked together and define a “workflow”. The components must be able to accept the data structure – no matter what components were used before, but not all inputs must be valid for the component. So it is possible that none of the inputs can be used by the component, but still the data structure itself must be accepted. To make the component more dynamic it also should provide settings like which input to use or the order to sort. These settings should, if applicable, dynamically change depending on the input.
– **Extensibility**: It must be possible for everyone, to extend the application with new components that offer new, possibly very specific, functions. Since there are many special analyses that cannot be put together with generic modules, it must be possible to include these in the list of available workers.
– **Embeddability**: Since the analysis shall be done with the data the users might just momentarily have entered, we require the analysis to run directly from the application, without first having to extract the data into spreadsheet or CSV files, or similar. This means that the analysis must be able to connect itself to another application and use the structure defined inside the program for its analysis. This might be a difficult requirement but without it using an analysis tool might not be so easy for the user.

A good overview of commonly used tools can be found at KDNuggets (Jones 2014) where some of the most known analysis tools are described (KNIME 2016; RapidMiner 2016; TableauPublic 2016). While these and many other different tools and applications for data analysis offer a variety of analysis methods and different options how to import the data, to the best of our knowledge there is no analysis tool available that can be integrated into an existing application. Therefore an in-depth comparison to these tools is outside the scope of this paper.

3. REALIZATION

We discussed the requirements for dynamic analyses. Now we take up these requirements and present our approach to meet them

.

3.1 Data Structure

A data structure is required that allows dynamic, flexible restructuring while still providing access to the data. Therefore the data structure for our framework consists of several elements.

– **Column Header:** This holds the important information about the specific field, such as the type and the display name. Since a field is basically a column in the database, we use the name of the field and the column. These are synonymous. The Column Header itself does not store any information about the value of the field, but serves more as reference information and metadata for the column.
– **Entry Value:** Is the smallest data type to hold the values. It holds a list of strings, which represent the values for a specific entry. This is necessary if a field has several options, e.g. different values for specific measurements. So every distinct value is one string, and all of them are saved inside the Entry Value.
– **Entry Map:** It maps the Column Header to the Entry Value inside a map. This map now represents a complete entry. It can easily be accessed because of the nature of the map. Therefore, writing and reading is no problem. Also editing values can easily be done.
– **Data List:** Is a list of all Entry Maps, which represents a complete data set. It also contains the list of all Column Headers that are in any of the Entry Maps. This serves as a utility method to allow components easy access to the list of all fields, without having to iterate over all entries. The list is generated by adding all unknown Column Headers whenever a new Entry Map is added to the Data List.

3.2 Worker

Each component, or "Worker" as we call it, can have multiple inputs and outputs of data. Some Workers do not necessarily have inputs, like Workers that retrieve data from the database, since they generate data without manipulating it. At the same time there can be Workers without outputs, like a Worker that allows the users to display the data as a diagram.

Properties: The Worker consists of inputs and outputs, settings, and the actual logic of the Worker. The latter either uses the input(s) or creates a new Data List, runs its logic according to the settings, and finally outputs the data or displays it. For this the Worker defines a list of Properties which can represent a setting. So for every setting type there must be an own property, e.g. text properties are common properties. The users can enter text (for example to describe a name) or combo properties, where the users can select one value from a list of values. Below, we describe the methods a Property has to implement:

– `getLabel()`: It returns the label to describe the property. This should make clear to the users which setting they can manipulate.
– `setValue()`: It is called by the GUI with the specific value. This is used to tell the Worker, that the value has changed and therefore must update its data structure and possibly additional properties.
– `addPropertyListener()`: All elements that are dependent to this property, can register themselves as a listener, which would be notified if this property has changed. The method is called when either new options are available for selection, or the value of the property itself was set.
– `onNewOptionAvailable()`: This is called if new options for this property are available. This causes all property listeners to be notified, so that the GUI can now display the updated values.
– `onSelectionChanged()`: This is almost identical to the method `onNewOptionsAvailable()`, but instead it is called when the value of the property is changed, e.g. after the `setValue()` method was called.

The Worker also defines the number of inputs and outputs. The users then connect different Workers, which basically is a directed graph or multigraph, with the nodes representing the single Workers, and the edges representing the connections between the Workers. The number of inputs can vary as some Workers require no input, some require an exact amount, and some can work with an arbitrary number of inputs. If the Worker provides an output this can be used to pass the data on to other Workers.

Data handling: Each Worker fulfills a predefined task, like retrieving or merging data. However, the output of the Worker is only defined after the input(s) and the Worker settings are set. Therefore it is not necessary to instantly generate the output, since the input(s) may change if a setting in a previous Worker has changed. Equally, it is important to establish at least the Column Headers of the data. This makes it possible to update the settings of the successive connected Workers. This is the reason why the output is separated in two parts:

– **Output Scheme:** This is the list of all Column Headers that will be returned by the Worker. This list is instantaneously generated as soon as an input or setting is changed. The successively connected Workers are immediately notified with an event, that the Output Scheme of the Worker was changed. This enables them to check if their Output Scheme has also changed. This list has the same value that the list of Column Headers inside the Data List should have in the real output. Therefore, Workers only need this list to define what settings they provide and what their Output Scheme is.
– **Output Data:** This is the Data List with the "real" output containing the data. This is only generated if necessary, since the composition of the data could take some time. A complete recalculation is not required if only the Output Scheme is important. The real data must be generated if a diagram representing the data has to be displayed or the values should be listed. This is done recursively with each Worker from the end requesting the Output Data of the Workers that are connected to its input. This means the first Worker or Workers have to be able to generate data without any input.

This separation into Output Scheme and Output Data allows a fast application of updated settings and rearranged inputs or outputs while still ensuring that the correct type is used.

Interaction with the graphical user interface: The Worker itself is only responsible for the logic. But since the users need to be able to easily arrange, connect, and configure the Workers there has to be a graphical representation. The graphical user interface is notified with events of changes in the properties. At the same time it uses the properties to notify back to the Worker if any value of the settings was changed, such as entering a text or selecting a new value. This allows the graphical user interface to be created independently of the logic, and therefore is not limited to a specific format. The exact design of the graphical user interface however is not part of this paper. Here we want to just describe the technical connection to the graphical user interface.

4. INTEGRATION

To reuse the analysis tool in different applications, it is important that the integration requires as few changes to the base application as possible. But since the analysis tool cannot know how the data is stored, or how the connection to the data is realized, the base application must implement some wrapper methods.

The analysis tool itself is composed in a `JPanel` or `JFXScene`. For this, the base application can either create a new `AnalysisSwing` or `AnalysisFX` instance, which both require an `IController`. The `IController` is the interface that serves as the combiner between the base application and the analysis. It provides the following methods that the base application has to implement:

– `getTableNames()`: This returns the list of different names of tables, that can be selected for the analysis. This should only return tables in which the users have entered data.
– `getColumnsForTable()`: This returns the columns for the given table, that can be included in the analysis. This should return only columns that are important for the users, but not columns that contain information that is irrelevant to the user. The expected return value is a list of Column Headers so therefore all columns have to be transformed into this format. This is important, because all future analysis options are based upon the information stored inside these Column Headers.
– `getKeysForTable()`: This returns the key columns for the given table. This can be used for example in the Combiner to provide default mappings. Also this method requires the returned values to be a list of Column Headers.
– `getProjects()`: The database can be structured in different "projects", which is a logical separation of different data sets. To also allow this separation inside the analysis framework, a list of a unique identifiers can be returned. This could be just a name or an integer, but can also be a more complex data structure, in which the `toString()` method returns the name of the project, to be able to display it to the users. If the separation into different projects is not desired or supported, this method can return `null`.
– `getDataForColumns()`: This returns the Data List for the given columns in the given table for the optional project. As stated, the analysis tool has no knowledge about the structure of the database, so the base application must generate the Data List. The list of projects is only required if `getProjects()` returns a value and can therefore be ignored if it is not applicable. The values that are returned would

most likely not the immediate values as they are stored in the database, but they are already translated into human readable form, e.g. by translating IDs into the appropriate values.

If necessary, all Workers can then use the `IController` to retrieve the data they require. This is the only connection data-wise needed for the analysis, as all further analysis is built onto the retrieved data. The base application therefore need not know about any internals of the analyses or vice versa. Since the analysis is done inside one panel, it can easily be included into the base application, which can decide where and when the analysis shall be displayed.

5. DEFINITION OF CUSTOM WORKERS

While creating an analysis tool, not all use cases can be known, since the area in which the analysis is used is not always known in advance. Therefore it is very important to be able to add new Workers, which exactly fulfill the requirements of the individual analysis to be applied. For this we defined a very simple API to allow new Workers to be easily implemented. To add a new Worker, the interface `IWorker` has to be implemented. It defines the basic functions that are required for the integration in the workflow.

- `getTitle()`: This method expects the name of the Worker to be returned as a string value. This name is displayed for the users inside the graphical user interface. It should be a short but meaningful name, which allows the users to instantly comprehend the function of the specific Worker.
- `getProperties()`: This returns a list of Properties which defines the settings of the Worker. With these settings, specific aspects for the Worker can be set. This list of Properties also includes Properties for the input and output, which define the connection to other Workers. The Worker is notified through the Properties if the input or a setting has been changed. Since the Properties are abstract classes, all methods of these classes must be implemented when creating a new Worker. This includes the displayed name, the logic for setting and retrieving data, and additionally, which Property values are displayed in the graphical user interface.
- `getOutputData()`: This returns the Output Data of the Worker after it has completed its job. If neither the input nor the Worker settings change, this will return the generated values from the previous call, otherwise the process has to be run again. Therefore, in this case the method has to call the `startWorking()` method and return the generated values after it has completed.
- `getOutputScheme()`: This returns the Output Scheme of the Worker, that would be returned in the Output Data of the specific Worker. The Output Scheme should be calculated with respect to the Output Scheme of the connected previous Workers, if any, and the settings of this Worker. If the input and settings of the Worker did not change, this method does not have to recreate the Output Scheme again, but can simply return the previously generated data. Additionally, this method does run the complete calculation method, but it calculates the Output Scheme.
- `onInputChanged()`: This method is called by the Properties to notify the Worker that something has changed and the Output Scheme and Output Data have to be recalculated if requested. This method, however, does not start the update process itself.
- `startWorking()`: In this method the actual logic is carried out. The input is collected by iterating over all input Properties and getting the Output Data of the connected Workers. This triggers them to generate their results themselves if needed by carrying out the same logic recursively. Then the result of the Worker is calculated with regards to the settings defined in the Properties. This method is usually only called inside the `getOutputData()` method.
- `setController()`: This method is used to set the `IController`, which is used for interaction with the base application. This is required to be an own method and not part of the constructor, since all Workers are created with reflection, therefore the constructor must be the default constructor. With the `IController` the Worker is able to query the base application for information that is possibly required for the Worker with regard to carry out specific operations.

After the Worker has been created, there are two options to register it with the application.

- **Direct registration:** The API provides a registry class, which allows Workers to be registered for inclusion in the analysis. In addition to the Workers available by default, the registered Workers can then be selected by the users. This method naturally requires access at runtime and therefore can usually only be executed from the base application.
- **Indirect registration:** Externally created Workers can be added to the analysis. For this all .jar files inside a specified folder (default "./analyses/workers") are analyzed if they contain classes that implement `IWorker`, and if so they are added to the list of available Workers for analyses.

Since the Workers use Properties to tell the graphical user interface what to display, it is important to also add new Properties if the available Properties are insufficient. This consists of two parts: The definition of the property itself and also of the definition of the graphical representation of the Property.

To define a new property, it has to extend the `Property` class. It can then define additional methods that are used by the representation of the graphical user interface. Then it can be registered together with the graphical representation in the registry.

6. EXAMPLES

As mentioned before there are types of Workers that fulfill different tasks. Here we want to give an example of the most common Workers that are sufficient for a basic analysis. There are far more different Worker types possible, but the focus here is to give an overview over the possibilities the Workers provide.

- **Retriever:** The most basic worker that will be used in every analysis. The Retriever, as the name suggests, retrieves data from the database. The users can define the fields and projects they want to include in their analyses, with the fields and projects being a structure for the data in the application the analysis tool is developed for. This would normally be the fields the users either want to filter, display, or further analyze. The Retriever is the only Worker that needs a connection to the database to get any data. It uses the `IController` to get the required data.
- **Filter:** The Filter can be used to filter out entries that are not required in the analyses. For example, an analysis about specific animals may only require the entries containing data of these animals. So the users can filter out all other animals using the Filter. The users have several options: They can specify the fields for which the data shall be filtered. The list of available fields is defined by the Output Scheme of the previous Worker. Depending on the column header, they can specify whether the value of the field contains or equals a specific text. For dates or numbers it is possible to check, if the value is smaller, greater or equal than a specific user input. It is also supported to define a combination of different fields that can be filtered at the same time.
- **Combiner:** This allows different data sets to be combined. The users can define the fields which should be considered when combining the data sets. The list of available fields is defined by the Output Scheme of the previous Workers. For example, the Combiner can be used if a user has already created two different analyses with different data sets, and now wants to combine the data for a third analysis. The Combiner searches for entries in the given list of datasets that are equal on the fields the user entered. The result of the combination can be compared to the SQL join. There are two possibilities, that either only entries having a match, or also entries that have no match are combined. In this case the other columns are filled with empty values. Then these entries are combined into a new entry.
- **Sorter:** This sorts entries according to the comparator set in the Column Header. It only has one input, but allows more than one column to be set as sorting column. This allows different priorities, in case of the values of the column with a higher priority are equal. This can be useful for example if a specific order of entries is required in a diagram.
- **Diagram:** The Diagram is the umbrella term for Workers that display the result in a graphical representation. They can be used in different and complex ways. As an example, we describe a two-dimensional, axis-oriented bar chart. The users can select the field which values shall be used for the x-axis. The list of available fields is defined by the Output Scheme of the previous Worker. The different values of this field are then listed as values of the x-axis. The number of entries for the given value are displayed on the y-axis. An example of a Diagram can be seen in the workflow example in Figure 1.

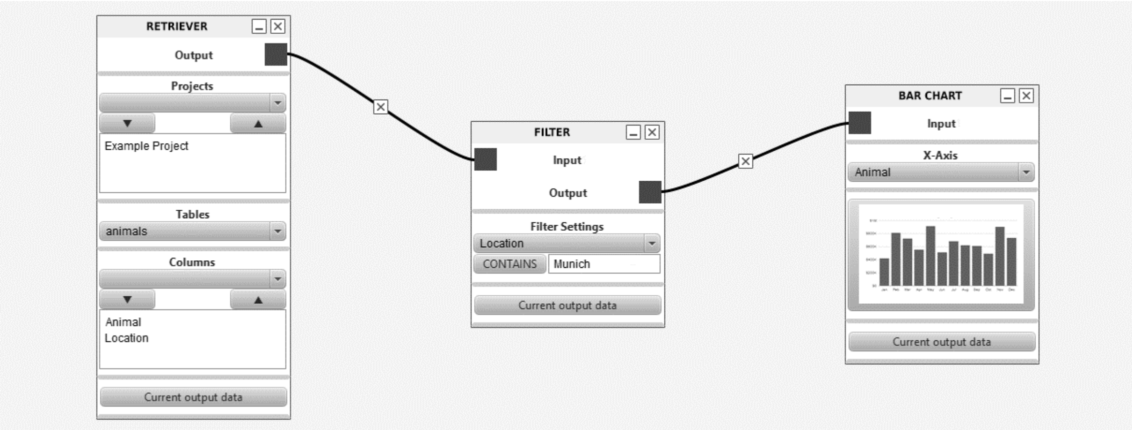

Figure 1. Composition of the analysis for animal distribution in Munich
The analysis framework was embedded to the zooarchaeological database *OssoBook* (2016)

7. WORKFLOW

We discussed the structure required for the analysis, and also gave examples of the most basic Workers. In the next step, we want to put the pieces together and describe how to build a typical analysis. As an example, we want to calculate a distribution of animals in Munich, and generate a graphical representation of the data as a bar chart. The composition of the data in the Analysis Framework is shown in Figure 1.

We take a sample table with the columns "*ID*", "*Animal*", and "*Location*", as shown in Table 1. Of course, in real scientific databases, a table like that would contain several more columns and datasets. Because of reasons of clearness we reduce the example data to a minimum.

Table 1. Sample data for Animals

ID	Animal	Location	...
1	Dog	Munich	…
2	Mouse	Los Angeles	…
3	Dog	Guarujá	…
4	Kangaroo	Melbourne	…
…	…	…	…

The analyzing process can be divided into three different steps:

- **Planning and collection of data:**
  Gather all required data from different sources and combine it, so it can be used for further processing.
  We first identify the fields we need in our analysis. These are: "*Animal*" and "*Location*". The field "*ID*" is not important for our goal and can be disregarded. The first Worker we use is a Retriever to get the necessary data. We configure it to get the fields "*Animal*" and "*Location*" only.
- **Processing data:**
  The data is processed to remove unimportant data or structure the data, e.g. by filtering or sorting it.
  Next we only want to filter all animals from Munich. Therefore we add a Filter. The input of the Filter is connected to the output of the Retriever, which makes the Fields "*Animal*" and "*Location*" available as options for the Filter. There, we select "*Location*" and define only to allow datasets in which the "*Location*" value equals the term "Munich".
- **Generating result:**
  The processed data is used to display a result like a diagram or any other visualization.
  The last Worker is a Diagram. It takes the filtered data from the Filter and displays a graphical representation of it. In our case, we choose the bar chart. We can now select the column, which values we want to use as the x-axis. We select the "*Animal*" column and the Worker generates the chart as seen in Figure 2.

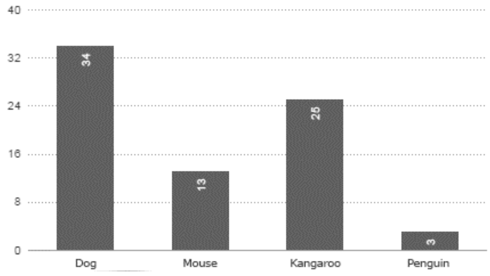

Figure 2. Possible result of the analysis in Figure 1

8. DISCUSSION

In this paper, we described a framework for generating analyses that can be embedded into a base application. The framework aims to be intuitively used by scientists without any IT background, inside their accustomed working environment. We identified the requirements for the framework, which must be fulfilled to allow working with it. Then we discussed the applicability of the requirements with some existing analysis tools. We described the realization of our tool, to be able to meet the requirements, and discussed how the framework can be integrated into a base application and extended to the demands of the user. Finally, we presented some of the basic Workers and used them in an example to show the analysis workflow.

While the framework can already be used for generating interesting analyses, there are still some issues that could be addressed in the future, to make working with the framework go more smoothly.

While the integration into the base application is straight forward and can easily done, it still requires both access to the source code and programming skills. Therefore, the typical users cannot do the integration themselves. This means that the developer of the base application has to integrate the analysis tool to provide the functionality to the users. For these cases, the framework could be extended to run as a standalone application, which can be connected to the database directly. This would require additional settings which handle the connection to the database itself. At the same time, a stand-alone tool could benefit from the same level of flexibility and extendibility that the framework offers while being integrated into a base application.

There are already a wide range of possible analyses, but still many additional Workers have to be created. These Workers should be part of the framework itself, since they can be used for analyses in different areas. Possible Workers include clustering algorithms, different diagram types, etc.

The logic handling the datasets is currently focused on processing speed. For this `DataList`s are often just copied and remain in the primary memory. For small datasets this is a fast and efficient way, but for complex databases with thousands or millions of entries, this method can quickly reach the computer's capacity limit. To meet this problem several solutions would be possible. The generated result could only be kept in memory during one operation, until succeeding Workers have used the Output Data. This would slow down the analysis process, since even for a small adjustment, all Output Data would have to be recalculated.

Additionally, the generated Output Data could be saved in a temporary file, so that main memory is freed because the Output Data is not used for calculation. Again, this would slow down the calculation process, since disk operations are relatively slow.

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INVESTIGATING THE IDENTITY THEFT PREVENTION STRATEGIES IN M-COMMERCE

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ABSTRACT

Mobile commerce has provided extended business opportunities for online organisations and made it easier for customers to purchase products on-line from anywhere at any time. However, there are several risks associated with it, especially the identity theft. Online organisations commonly use electronic commerce approaches; however, these have some limitations in the m-commerce. This paper presents an evaluation of the approaches used in identity theft prevention and suggests guidelines to overcome the weaknesses in m-commerce. A case study approach, with semi-structured interviews was used as the data collection method. Thematic analysis method was adopted for the interpretation of the qualitative data. Themes and codes were created in relation to the processes, methods, approaches, activities and tools used for identity theft prevention. The results show that online organisations are using same approaches of identity theft prevention for all online business transactions, while m-commerce has some unique characteristics for which e-commerce arrangements are not effective. On the other hand, these arrangements are not evaluated for their effectiveness in m-commerce. This study suggests for the assessment of identity theft prevention system for effective functionality in m-commerce and forward guidelines for evaluation of the system in m-commerce. This study makes an important contribution by suggesting strategies for identity theft prevention in m-commerce.

KEYWORDS

Mobile Commerce, Identity Theft, Prevention Strategies, Mobile Security, Network Security

1. INTRODUCTION

Mobile commerce (m-commerce) has become a popular channel for consumers and online organisations. It allows the organisations to provide shopping facilities any time, at any location (Chong, Chan, & Ooi, 2012) thus, customers' get 24/7 shopping facilities. Such facility of online shopping is also espoused with many risks especially the identity theft (IDT). Currently, the online organisations are using various tools and technologies to prevent IDT in online transactions, yet they fail to control it. The major reason behind that failure is using electronic commerce (e-commerce) tools and techniques for all types of online transactions. Although mobile devices have unique characteristics such as touch screen, wireless network, limited bandwidth and memory space, wireless encryption, operating systems and limited processing power (Goyal, Pandey, & Batra, 2012; Nie & Hu, 2008), which may cause ineffectiveness of e-commerce arrangements.

In addition, these approaches have not been evaluated in m-commerce (Vidalis, Stafford, Angelopoulou, & Derby, 2014). To address the problems of IDT in m-commerce, this paper evaluates the approaches used by online organisations for prevention of IDT in m-commerce. The results show that the case organisation neither uses m-commerce specific systems, nor assesses the vulnerabilities of the systems to prevent IDT in m-commerce. The prevailing IDT system in the case organisation has been evaluated in m-commerce, the weaknesses are highlighted and suggestions are given to overcome these weaknesses. This paper makes an important contribution by suggesting approaches for IDT prevention in m-commerce.

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2. BACKGROUND

M-commerce is growing rapidly and has become an important channel in online industry. In the UK, sales through mobile devices have increased by 186% in 2014(IMRG, 2014). Along with opportunities m-commerce also has many challenges especially the IDT. Customers' data security has a critical impact on m-commerce, as online retailers who do not secure their customers' data lose their customers (Wu & Wang, 2005). Surveys conducted in the USA and the UK on m-commerce challenges show that about 92% retailers are concerned with fraud risk (Kount, 2014) or are unable to manage identity frauds (Khan & Hunt, 2013).

The number of approaches and techniques are presented by various researchers for IDT prevention such as; network security (Al-Haj & Al-Shaer, 2011; Ray, 2013), internal and external data protection, encryption technology (AnnMcGee & Ralph, 2015; Peltier, 2013), customer education (Arachchilage & Love, 2014), threat and risk assessment (Beaumier, 2006), data access management and authentication systems (WenJie Wang, Yufei Yuan, & Archer, 2006). Although these all arrangements are made to prevent IDT yet the fraud is increasing (Khan & Hunt, 2013; Kount, 2014). The major cause of which may be the lack of evaluation of such systems in m-commerce. The online organisations use same e-commerce validation approaches for all types of transactions but these are not effective for m-commerce (Khan & Hunt 2013), so there is a need to investigate the arrangements for effective prevention of IDT in m-commerce (WenJie et al., 2006).

Technologies with unlimited benefits have also some challenges if not deployed and evaluated properly (Phan & Vogel, 2010). The functionality of preventive technologies in fraud area is a critical issue and most of these technologies are not compatible with m-commerce transactions (Nie & Hu, 2008). As the prevention technologies are there to help mitigate the risks, but firms have to assure that these are being applied properly in the problem-solving domain (Phan & Vogel, 2010) . Lack of evaluation of prevention system in m-commerce is also a major obstacle to IDT (WenJie et al., 2006). For effective functionality, the IDT prevention systems should be assessed for their vulnerability (Soomro, Shah, & Ahmed, 2016; Vidalis et al., 2014), which will help to make the necessary changes to enhance their performance in m-commerce.

So it may be argued that having no prevention system is a failure, but having the system with improper implementation and lack of evaluation is same as having no system. Therefore, this study investigates the limitations of IDT prevention system and suggests guidelines to improve its effectiveness in m-commerce.

3. METHODOLOGY

Qualitative case study is helpful to investigate and evaluate the effectiveness of technology to understand what happened or how and why people are responding; and phenomena of people to the situations in natural settings related to technology (Kaplan & Maxwell, 2005; Yin 2014). Therefore, the case study approach was used to capture the opinions, perceptions, processes, knowledge and responses of people about the identity theft prevention in m-commerce.

For qualitative data collection case study approach was adopted and semi-structured interviews were conducted with seventeen representatives of an online retail firm based in the UK. The questionnaire was developed using existing literature. The questionnaire was categorised into various dimensions of IDT prevention such as information security, encryption, network security, and authentication system. Some additional questions were also asked where needed to grasp the in-depth information. The data was collected in the months of July and August 2015. The average time for each interview was about 40 minutes and recording was done with an audio recorder.

A variety of respondents were selected from various levels of management and a few operational staff for data collection. The respondents were fraud managers, IT security managers, top executives, a fraud analyst, a fraud advisor, fraud investigators and others concerned with the prevention of identity fraud. Consent for data collection was sought and an agreement of confidentiality was signed by the researcher and the company's management to comply with the ethical aspect of this research.

The qualitative data analysis software NVivo 10.0 was used to organise, code, group and analyse the data from interviews. Using the thematic analysis technique, the data were carefully analysed. Themes and codes were created according to approaches, activities and tools related to the parameters of identity fraud prevention. The findings and results of data analysis are discussed below.

4. RESULTS AND DISCUSSIONS

4.1 Identity Theft Prevention

Prevention is commonly used to stop fraud from occurring; it is a set of activities that help to stop identity fraud before being detected as suspicious or to create hindrances to committing IDT. The findings show that the organisation has implemented different measures for IDT prevention, mentioned as below.

4.2 Network and Information Security

The findings so far show that the organisation has implemented various approaches or measures at network and communication level to prevent IDT in m-commerce. These measures are firewall security, network threat vulnerability analysis, anti-virus system, network access security and encryption technology. These measures are investigated below in m-commerce.

4.2.1 Firewall and Database Security

Firewall is the important factor in network access and information security because it prevents the unauthorised access at the boundary of network and infrastructure. The firewall has to be in line with security policy (Al-Haj & Al-Shaer, 2011; Ray, 2013). The findings show that the organisation has contracted network security from a third party which provides security services for network communication, anti-virus, firewalls, IDS and data base security. Respondents (1 & 4) reported that: *"Third party manages our infrastructure and network…and they manage firewalls, antivirus, IDS and database security."*

The findings show that network security is constantly monitored and updated according to threats by third party and present a security matrix to the case organisation. In security policy of the organisation it is mentioned that firewall administrators have to get approval from the information security department. They document all the information about the rules and conditions that they implement on firewalls for further network security audit (Beaumier, 2006). As the organisation relies on third party for their network, firewall, and information security management, which may leave some weaknesses unfocused. Therefore, the organisation should consider the neutral organisation to evaluate effectiveness especially for IDT prevention.

4.2.2 Network Threat and Vulnerability Assessment

The security policy of the organisation explains that network security is randomly evaluated by a third party at least twice a year. Respondent (4) said: *"third party has to demonstrate to us the effectiveness of these systems but I don't know how they are evaluated."* This shows that third party is evaluating the effectiveness of the network and IT infrastructure against threats. However, the case organisation does not know what they are evaluating and how they are evaluating. Such information would help the organisation to identify the threats and verify the methods of evaluation and their effectiveness (Tsavli, Efraimidis, Katos, & Mitrou, 2015). Participants (1 & 4) have explained that the organisation relies on the security provided by third party and it is deemed to be fairly secure. Although the organisation has specific network security and access policy but methods of evaluation and vulnerability assessment are not clearly suggested. Therefore, the organisation should design such a policy which highlight the evaluation methods of network security and data access policy compliance (Soomro et al., 2016; Tsohou, Karyda, & Kokolakis, 2015).

4.2.3 Encryption (SSL, PKI, WPKI)

For encryption the findings show that the organisation is using a standard Secure Sockets Layer (SSL) kit to encrypt the data that comes from customers through an e-commerce website and other third parties. Respondent (3) explained that: *"No, I can't tell you that (how we secure the data transmission in mobile commerce). I can tell you that we have standard SSL and PKI in e-commerce."* This argument reveals that the organisation uses SSL and Public Key Infrastructure (PKI) for data encryption in e-commerce, but it is not clear that how are they securing data in m-commerce. While in m-commerce, normally at the gateway, the data is decoded from wireless transport layer security (WTLS) protocol to encode in SLL, creating the chances of IDT, because during that process the information is in plain text (Ray & Biswas, 2011).

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The implementation of strong encryption, digital signatures and SSL for data security and authentication require more computational power and enough memory space while mobile devices have limited processing power and memory space (Goyal et al., 2012; Nie & Hu, 2008). SSL and digital certificates could be useful for data security at the network level but they could not contain any security features that provide protection against online IDT attacks at the application level where fraudsters can capture information in plain text before encryption (Ray & Biswas, 2011).

4.2.4 Information Communication Security

Information communication security would be considered as fundamental and the first step in online business (Peltier, 2013). In this regard, Respondent (4) expressed the possibility of the risk of IDT when credential data is transferred from the e-commerce website to the backend database servers. He stated: *"... data is encrypted by SSL but how do we get from the e-commerce website to the backend (server)? I don't know, but I do know it goes through the firewall so although our backend is protected I don't know whether it is encrypted or not but I think we cannot accept that to be the case on an insecure internet."*

This implies that the internal infrastructure and database servers are secure but the organisation has not evaluated the process of data transmission from an e-commerce website to the backend database servers because the organisation assumes that it would be encrypted and secure from threats of IDT. Therefore, it is suggested that the organisation should evaluate the data transmission flow not only from e-commerce website but also from mobile applications to the database servers (Beaumier, 2006). It may be concluded from discussion, that the organisation has strong network data protection at the internal level but there are some limitations in m-commerce at the customer level, mentioned in Table 1.

Table 1. Limitations and suggestions for network and information security measures

Measures	Limitations	Suggestions
Threat assessment	Third party is evaluating effectiveness but organisation does not know the process.	The organisation should analyse its methods of network security evaluation (Amori, 2008).
Firewall, database and network access	The organisation relies on security provided for firewalls, anti-virus, database and network access by third party and it is deemed to be fairly secure.	The organisation should ensure the security provided by third party according to their network security policy and analyse the firewall security through penetration testing and vulnerability test (Eisen, 2009).
Encryption	The organisation uses standard SSL and PKI which are not effective in m-commerce. The encryption key could be tempered by viru and malwares on the customer side.	The organisation should implement strong encryption such as point-to-point encryption of hardware; and should verify the encryption signature key during network authentication (AnnMcGee & Ralph, 2015).
Information flo security	The organisation does not evaluate the security of information flow from third party e-commerce platforms to the database.	The organisation should evaluate the in-depth data transmission flow not only from the e-commerce website but also from mobile applications to the database servers (Amori, 2008).

Table 1 shows that for preventing IDT, the organisation have implemented various network and information security measures. These measures are secure and implemented according to standards of e-commerce. The results show that the organisations are not giving proper attention to assessment and evaluation of these measures in m-commerce. Therefore, the organisations should examine the weakness and loopholes in network and information security process with respect to channels (Borum, Felker, Kern, Dennesen, & Feyes, 2015). The organisation should also ensure the security of data and information flow from business partners, third party contractors and customers (Borum et al., 2015; Tsavli et al., 2015).

4.3 Business Platform Security

The business platform is the channel through which sell and buy the products and services. In m-commerce, the business platform consists of the mobile device, mobile business application (apps) and wireless network for communication. The entities related to business platform security are discussed below.

4.3.1 Mobile App Security

The findings show that the organisation has a mobile application. it is developed by a third party and is managed by the e-commerce department. Most of the participants confirmed that more than 70% of orders are placed through mobile devices. Therefore, it is necessary to secure their mobile application from identity fraudsters who create threats to obtain their identity and credential information by exploiting mobile technology. In this regard, most of the respondents explained that the organisation has a mobile application but they do not know what security parameters are implemented for the prevention of IDT. For the effectiveness of mobile application, respondent (4) explained that: *"When the mobile app was produced we assessed the vulnerably point of view by the third party".*

The statement reveals that the organisation has evaluated the vulnerability by testing mobile applications once, at the time of its deployment. However, the literature suggests that m-commerce provides enough information and security through a mobile application that could be helpful to prevent theft in m-commerce. Because in m-commerce the online retail organisations are installing their applications direct to the customer's devices, it provides direct access rather than by clicking on URLs in e-commerce (Khan & Hunt, 2013). Therefore, it is suggested to the organisation that they enhance the security of their mobile application by adding extra security functionality such adding antivirus signature verification functionality, communicate through a virtual private network (VPN), and use an IMEI number for verification and authentication of customers. It is also suggested that the organisation should evaluate the effectiveness of their mobile application on a regular basis.

4.3.2 Anti-Phishing Technology

The organisation has purchased anti-phishing services from a third party which employs various means to provide end-to-end protection against phishing. These include monitoring and detection of phishing sites, real-time alerts and global network blocking, site shut down services, forensics and credential recovery and bait operations. Participant (4) said: *"Third party is monitoring fraud brands and shutting down phishing sites; on customer complaints sites about phishing again they respond to that and take those sites down."*

The findings show that anti-phishing measures are in place but only for the e-commerce platform. However, in m-commerce fraudsters could obtain credential information through other phishing methods such as mobile app, ad-jacking, SMshing (SMS phishing), Vishing (phishing thorough phone call), send URLs in emails, or installing malicious apps on a customer's device and through social media (Jakobsson & Myers, 2006). The findings also show that the organisation receives complaints from customers about phishing sites and third party responses to those complaints. This shows that the anti-phishing service is not as effective at detecting phishing URLs because customers are informing the organisation about illegitimate sites or fraudsters who are using other channels to trick the customer. In this regard, the organisation should consider monitoring and the detection of phishing mobile apps at mobile app store and employ extra measures to detect other methods of phishing. The limitations and suggestions are summarised in Table 2.

Table 2. Limitations and suggestions for business platform security measures

Measures	Limitations	Suggestions
Mobile applicatioi security	The organisation A evaluated the vulnerability of mobile applications only once, at the time of its deployment.	The organisations should regularly evaluate the mobile apps concerning IDT prevention (Borum et al., 2015; Tsavli et al., 2015) and enhance its security by adding extra security functionality (Eisen, 2009).
Anti-phishing technology	The anti-phishing service is not effective to detect phishing URLs because receiving complains about illegitimate sites.	The organisation should implement continuous monitoring and a phishing detection system for mobile apps (Bose & Leung, 2007).

Table 2 shows that the organisation has implemented various prevention measures to secure business platform. These measures include internal anti-virus, anti-phishing technology, wireless (mobile) encryption. The measures were implemented for e-commerce and internal network security but mobile app which may increase the IDT risk at customer side. Therefore, it is suggested that the organisations should evaluate the vulnerabilities in m-commerce and enhance the security by adding extra features such as adding anti-virus in apps, VPN, SSL encryption and anti-phishing technology for mobile apps (Eisen, 2009).

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4.4 Identity Verification and Validation (Authentication) System

The findings show that the organisation has a standard authentication system through account numbers and passwords. Other security measures and tools are used such as SSL, password protection, database security and customer data protection, but customer authentication is an important step in checking and verifying a genuine customer at the time of login or account access. Respondent (2) explained that: *"Just standard on the website, such as account number, login details, and password - obviously if you don't have these details then it would not allow you to log in but that's how fraudsters are obviously obtaining the credentials."*

The findings of the authentication process show that the organisation has a standard authentication system through account numbers and passwords. It also shows that fraudsters illegally obtain these credentials via hijacking the customers' accounts and placing online orders. Literature suggested biometric authentication such as fingerprinting, voice recognition, keystroke dynamics, facial recognition and eye retina recognition would enhance customer identification and non-repudiation of information security (Karnan, et al., 2011; Usman & Shah, 2013). However, WenJie, et al., (2006) illustrates that the biometric authentication system could be effective for authentication but it also contains some limitations such as once biometric information theft has taken place, it is difficult to recover. Concerning this, respondent (1) explained: *"We are looking at logins and the amount of time of people are using certain keys* [keystroke dynamics] *and we're able to identify patterns; as well as this we are researching photo recognition systems with a view to the future."*

This shows that the organisation has concern about authentication systems and they are researching the biometric system. M-commerce supports for biometric authentication because it contains a live camera, touch screen and built-in biometric technology such as fingerprinting, eye retina verification, palm verification and face recognition as well as voice recognition (Teh, Zhang, Teoh, & Chen, 2016). M-commerce also provides a unique international mobile equipment identity (IMEI) number and contact number that could be helpful in the identification of a customer by implementing multifactor authentication. This technology is now widely used in large banks to authenticate the customer through a mobile app (Gu & Peng, 2010). Using this method of authentication, the customer devices are registered alongside their accounts at the time of downloading the app. The organisation could utilise these technologies and methods in order to implement an effective authentication system. The strategical steps towards the effective prevention of IDT in m-commerce are highlighted below in figure 1.

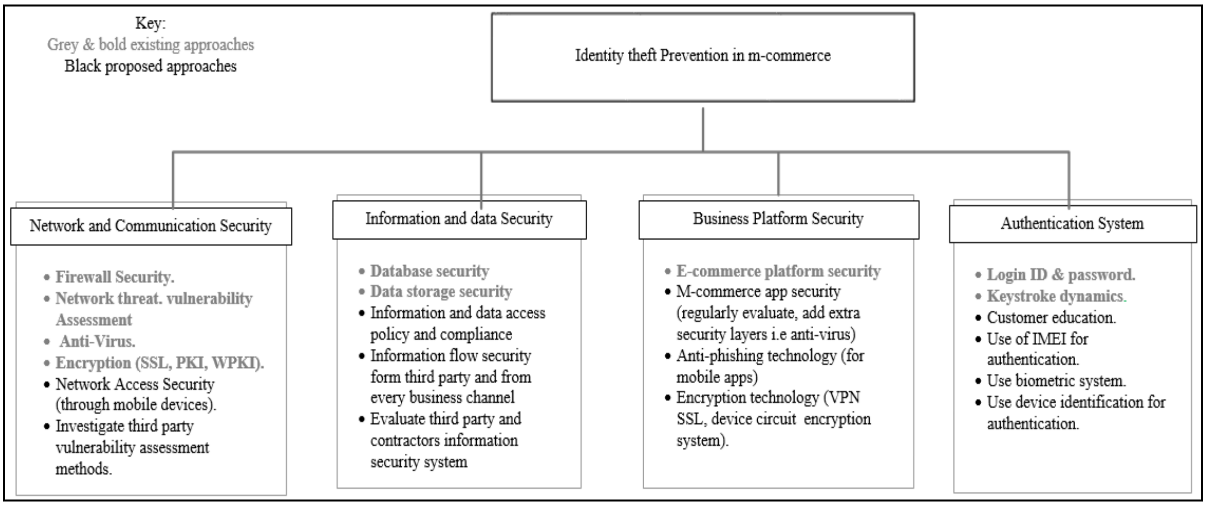

Figure 1. The strategy for identity theft prevention in m-commerce

The Figure 1 represents the suggested methods and approaches for IDT prevention. As the above findings show that organisation are more focusing on technological methods (anti-virus, encryption technology, firewall security, data security, login ID and password, keystroke dynamics and platform security etc.) to prevent the IDT. However, literature also suggests additional preventive steps that would be helpful in IDT prevention in m-commerce. These steps include; enhancing skills, knowledge and training to employees that they could evaluate and improve the performance of tools (Borum et al., 2015; Tsavli et al., 2015). The existing measures are also included on account of their effectiveness and usability in m-commerce.

So far, this study finds that the online organisations are using the e-commerce approaches for IDT prevention in m-commerce, which is a major obstacle towards its effectiveness. On the other hand, such prevention systems are not evaluated for their vulnerabilities in m-commerce. So this study suggests proper alignment of IDT prevention system with m-commerce characteristics and also forwards guidelines to assess and improve the effectiveness of IDT prevention approaches in m-commerce.

However, these measures are not sufficient to prevent IDT. So with the help of literature additional approached are highlighted to overcome the existing gaps in prevention of IDT through mobile devices. In addition to the adoption of these tools and approaches this research also suggest regular evaluation of these tools and approached to identify the limitations and enhance their performance in m-commerce. Application of suggested tools and approaches will help the online organisations to prevent IDT and related fraud losses and enhance customers' trust.

5. CONCLUSIONS

An investigation of the IDT prevention measures in m-commerce has been presented. The results show that the online organisations are using e-commerce approaches to prevent IDT in m-commerce. Although, these approaches have some controls on IDT in general but have some limitations. Firstly, these approaches are developed for e-commerce, so are not effective in m-commerce. M-commerce has unique characteristics, which cannot be addressed through e-commerce approaches. Secondly, these measures do not specifically address the challenges related to IDT in mobile devices. This study suggests that measures implemented in IDT prevention should be capable of addressing challenges in m-commerce. So there is a need to establish specialised measures capable of counterfeiting the IDT in m-commerce.

The results also show that the online organisations do not evaluate the measures used for IDT in m-commerce. Implementing measures without knowing their effectiveness is a greater risk. So this study suggests that the online organisations should systematically evaluate their IDT prevention measures in m-commerce. Thus, the research makes a significant contribution by highlighting the limitations of existing IDT prevention approaches in m-commerce. The study also suggests the guidelines for the effectiveness of existing approaches in IDT prevention which will help the online organisations to manage the vulnerabilities of their systems.

This study has some limitations, since research was conducted in the UK retail industry. However, other countries have different concepts, methods and approaches for IDT prevention. This research suggests future studies using data from other developed and developing countries to explore issues and remedies.

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ELECTRONIC INVOICE IN COSTA RICA: CHALLENGES FOR ITS IMPLEMENTATION

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ABSTRACT

This paper discusses the current situation that Costa Rica faces around fiscal issues and high evasion rates. Using actors and multidimensional analysis, it proposes the electronic invoice as an e-government strategic solution that will close the gap around tax evasion and the government incomes. The success achieved by Brazil in this area provides a source of good practices for increasing Costa Rica's implementation feasibility.

KEYWORDS

Costa Rica; Brazil; Electronic Invoicing; Actors; Public Fiscal Policy; e-Government

1. INTRODUCTION

One of major Costa Rica public finances problem is related to fiscal deficit. Lack of adequate controls for tax collection and tax evasion that exceeds the fiscal deficit, points that solving such issues is essential to achieve fiscal consolidation. One way to do so is to analyze how may contribute electronic mechanisms such as the "electronic invoice" as other countries like Brazil or Chile have implemented. Because the solution shall include variables in diverse domains, different factors coming from political, economic, social, administrative and technological dimensions need to be considered. This paper aims to perform an analysis that can provide guidelines for a strategy that allows the creation of a new digital tax platform, which includes the promotion of the electronic invoicing in the country, complementing a system of digital tax declaration and registration. The new platform will help to strength Costa Rica's Treasury efficiency enabling to fight tax evasion by improving and simplifying the tax collection processes. In section 2 we review Costa Rica's current fiscal issues. Section 3 presents theoretical concepts relevant to e-government and its relation to fiscal issues. Next, section 4 details briefly the methodological approach. Sections 5 and 6 describes Costa Rica current situation and Brazil's history on its implementation of the electronic invoice. Section 7 presents between the quantitative assessment based on actors both for the current Costa Rica's situation and how it can be modified to project a feasible solution. Some recommendations are pointed at the end of the paper.

2. COSTA RICA'S FISCAL ISSUES

A current priority of Costa Rica's government has been to find ways on handling public economic issues. Fiscal deficit s widely recognized as one of the main problems on public finances. Solutions include a fiscal reform for creating new taxes to help on fixing the situation. However, the creation of new taxes is a measure that does not have the support from diverse actors, especially political opposition or enterprises. One of the main arguments against the fiscal reform plan, is the fact that there is a very high tax evasion, which, according to information published in media (ACAN-EFE, 2016), exceeds by 8% the country's Gross Domestic Product (GDP), while the general government deficit, according to the same source is near 5% of the GDP. Thus by a simple arithmetic calculation, a correct tax collection will dismiss the need for new taxes. Controlling the evasion will generate fiscal surplus for government. As detailed at the Presidency of

Costa Rica official website (Costa Rica Gobierno de la República, 2016), the Treasury Secretary has conducted studies that demonstrate the high degree of evasion. For example, tax authorities reported that with the implementation of evasion control plan executed in 2015 over 731 free lancers professionals' unpaid taxes represent more than USD$2.1 million, which could go up to USD$3 million after interests and fees. Simple and clearly an immediate question arises: how can Costa Rica develop mechanisms for avoiding tax evasion in order to balance fiscal deficit? International success experiences may provide guidelines for such objective. The Brazil's electronic invoicing implementation is considered one of the leaders in this kind of systems (Da Silva, et al., 2016). The Argentine EDICOM site (EDICOM, 2015), indicates that the penetration of the electronic invoice in Brazil for the areas of Business to Business (B2B) and Business to Government (B2G) has already exceeded 90%, which consolidates the country, along with Mexico, as world leaders using this technology.

3. THEORETICAL APPROACH

As described in (Cortés-Morales & Marín-Raventós, 2012), e-Government solutions can be categorized as a multidimensional problem where actors' performance is a key success factor for the success of a public policy using e-government solutions (Cortés-Morales, 2015). The challenge for researchers is to find evidences on different dimensions (political, economic, social, administrative and technological), and mapping such findings to specific actors for computing the feasibility of the implemented and/or proposed solution. From the perspective of e-Government concept, the Electronic Tax Platform Solution can be categorized into Digital Government typologies (Fountain, 2001), primarily as a Government to Business (G2B) solution, since it focuses on providing a platform on which all production companies can interact with the government to present its accounting and tax information. Also it encourages the creation of solutions Business to Business (B2B) since companies should exchange digital invoices to conduct their business interactions. On the other hand, there is a component that could be considered Government to Government (G2G) as different government entities within the Treasury House should interact: the Taxes Department, the Fiscal Compliance Force and the National Customs Service.

4. METHODOLOGICAL APPROACH

Description of the current fiscal situation in the Costa Rica shows that efforts taken have not delivered the expected results, so a public policy approach emphasizing the formulation stage is proposed. In addition the comparative Case Study Research Strategy (Yin, 1994) between Costa Rica and Brazil is used to incorporate elements that proved to be successful in Brazil. Stating specific questions for public policy formulation stage and using multidimensional analysis (Cortés Morales, 2016) will permit to gather the elements for the solution, providing guidelines for next stages of the policy (decision, implementation and evaluation). Based on documental sources we proceed to perform the multidimensional analysis that includes political, economic, social, administrative, and technological variables needed for the policy formulation. Mapping the findings to specific actors permit to compute values on characteristics of "veto power" and "support" following specific heuristics. Institutional resource, for instance, is important as long it's not currently good enough for the solution. The more scarce a resource is, the more its value is near to 1 (or near to 0 on the contrary). For a specific actor, if institutional resource would permit that she or he acts adequately in the solution, such actor would have a value near to 1 on that specific resource. Similar rational is applied to other resources of veto power and actors' support actions or public declarations. Aggregated weighted average on veto power of actors' support computes a *feasibility* value varying from 0 to 1. The closest the value is 1, the more feasible is the solution analyzed.

5. COSTA RICA CASE

5.1 Political Dimension

Regarding the institutional frame, Costa Rica has two main laws on tax regulation and an executive resolution describing the application of tax burdens, their definitions and processes of the government to collect and ensure their payment (Ministerio de Hacienda de Costa Rica, 2016). The mandatory use of electronic invoice has been already a topic on the agenda of the Treasury House. As evidenced in (Cordero Pérez, 2015), efforts are underway on issuing a resolution for progressively establish a mandatory requirement. Grounded on the resolutions published in (La Gaceta, 2009) and its subsequent updates in September and August 2011, in which the guidelines for voluntary use of digital media were defined, with the law's support, entitling the government to issue such resolutions. There are also international agreements that Costa Rica has signed, such as the application to be a member of the Organization for Economic Co-Operation and Development (OECD). Specifically, OECD seeks every member to develop mechanisms for fiscal transparency as well as the creation of public policies to avoid tax paradises. Particularly for the OECD, although Costa Rica has not completed its final inclusion, the incorporation process requires the implementation of political, practical and legal instruments in different areas, including the tax area. Even there is already an institutional structure that would support such solution, one crucial factor is to define who would be the bill authorizer entity, an element that has been reason for debate in recent years. In particular, the Central Bank of Costa Rica (BCCR) is emerging as a strategic partner to take on this role, as long as it complies with the guidelines and regulations that the Treasury House defines. BCCR will take an operative role while the Taxes Department will be the responsible for the Electronic Tax Platform. Considering the decision phase, given the authority granted by the existing tax legislation, the Taxes Department can define the mechanisms for an efficient tax collection. Additionally, laws already provide the possibility of applying technological mechanisms as part of tax processes, which enables the Treasury House to issue rules and regulations that promote the new digital platform.

5.2 Economical Dimension

As described, in several existing laws a percentage of tax revenues is intended to help on founding the taxation process management. Therefore, to maintain this model, the solution will be self-sustained through tax collection. As stated by (Cordero Pérez, 2015), the authorities recognize that electronic invoice will generate an increase of about 10% in the government income. The cost of using electronic invoicing is 28 times less than conventional printed invoice, without considering costs generated by processing errors, loss or storage. As explained by (Ramírez, 2016) electronic invoicing is highly profitable for businesses. It has major effects in reducing printing costs, documents distribution, and fuel consumption required for archiving and retrieving a particular document, as well as invoice processing. On the other hand, the initial investment, which represents a high cost, could be covered by alternative means, for example, inviting state banks to develop and manage the solution as an authorized collection agency; similar to other successful models already established, leveraging the existing situation with entities such as the Banco de Costa Rica (BCR), who has implemented solutions for issuing passports and licenses (Cortés-Morales & Marín-Raventós, 2013).

5.3 Social Dimension

Given the corruption scandals and media news about major companies that evade taxes in the country, the Electronic Tax Platform may be considered as an option to provide a greater ability to control tax transactions. At the same time, it could raise the citizens' level of confidence, not only in the government's ability to make an efficient tax collection, but also bringing transparency in their actions. Since corruption is one of most sensible issues on Costa Rica's population (CIEP, 2013), a solution that could fix such problem may be valued in a good way by citizens. This is accompanied with improved efficiency on government among other benefits as in the environmental field by eliminating the use of paper and ink which can be leveraged to achieve established country goals like reducing the carbon footprint.

5.4 Administrative Dimension

The Tax Department General Manager stated in an interview (Alvarado, 2016) that they have plans for a new platform for handling electronic invoicing and they were finalizing details on selecting a technology partner for the solution. Even there was a previous agreement with the BCCR as technological partner, it was suspended. It would be valuable to reconsider the BCCR as the certifying entity since they already have the experience of implementing SINPE (National Electronic Payment System). Such experience can serve as a basis for incorporating electronic invoices certification and provide the necessary guidance to the selected technological partners. In addition, a project team must be established, that should be formed by personnel from the Treasury House, who define the requirements ensuring that tax legislation is applied correctly; the BCCR Board, who would be in charge of the design, implementation and testing of the solution; and an Advisory Committee which shall include people that was involved on implementing solutions in countries like Brazil, Chile, Mexico and Spain, who can, from their experience, provide its expert advice on best practices and strategies to ensure success. The General Comptroller must be responsible for ensuring an adequate project execution. Treasury House employees, specifically the Tax Department, should be trained so that they understand the new platform and its use for the benefit of their own work and the taxpayer.

5.5 Technological Dimension

Lessons learned from successful implementations in other countries like Mexico, Chile, Spain and Brazil should be a source of good practices. Broadly it can be noticed the use of systems based on SOA, through XML web standards. Such technological approach avoids obsolescence of platforms as they become no longer compatible with new operating systems versions, as happened with previous government solutions (Eddi-7 and Declar@7) which Treasury House provided some years ago. In addition, the data integration with a centralized system allows the automation of the delivery process, consultation and validation of forms and invoices, as well as data mining for intelligence for the control of tax collection.

6. BRAZIL'S ELECTRONIC INVOICE HISTORY

The Brazilian Government identified serious flaws in its administrative capacity to ensure a proper tax management and the need to solve three basic problems: a) Integration and mechanisms for sharing information between its states (Brazil is a Federation of States), b) Modernize the tax management to reduce the level of bureaucracy, and c) Restructure and automate tax management mechanisms to deal with high volumes of transactions and reduce costs. The Brazilian Government was clear that its problem was a disparate system of tax collection from their federal states, which caused a higher investment in the administrative field to control taxes, at the time that relations between government and companies were affected by the fact they seek loopholes to evade taxes under the pretext of the extreme complexity. As detailed in (Henrique Diniz, et al., 2007), the first formal studies for the implementation of a digital public policy were drawn up by the "Grupo de Trabalho em Tecnologia da Informação (GTTI)", which was a commission created by presidential decree on April 3, 2000, whose aim was to review and propose public policies guidelines and standards to govern the new forms of digital interaction. The result of the commission was the Electronic Government Program of Brazil in 2001.

As described in (Anon., 2016), by December 2003 the constitutional amendment number 42 introduced the paragraph XXII in the Article 37 of the federal constitution. The amendment determines that all tax administrations of the states and federal districts of Brazil must work in an integrated manner ensuring that records and tax information are shared among them. To meet the mandates of the amendment, from July 2004 national meetings of tax administrators (who manage the establishment of technical cooperation protocols) are made. In March 2005 a group of representatives of the NF-e Project ("Nota Fiscal Eletrônica", electronic fiscal invoice) from the Treasury Departments of São Paulo and Rio Grande do Sul traveled to Chile to learn from their experience, considering that they had successfully implemented an electronic billing system by 2003 (Oller de Mello, et al., 2009). The study in Chile, concludes that there is a technical feasibility for Brazil invoice system. The main challenge would not be technological, but how to overcome the obstacles to the creation of a single invoice national standard that would be accepted by all state agencies and the federal tax authority. Subsequently, as described in (Anon., 2016), by August 2005 was approved the development and implementation of the "Sistema Público de Escrituração Digital (SPED)" and the e-invoicing project "Nota Fiscal Eletrônica (NF-e)" inside the program "Projeto de Modernização da Administração Tributária e Aduaneira (PMATA)". (Roseno, 2012) explains that the SPED will become the national framework for the unified data processing which will operate based on digital certificates giving legal validity to the Accounting and Tax in digital format. In September 2005, national legislation for electronic invoicing (NF-e) was approved, starting the implementation of a pilot project where 6 states, the federal government, and 19 voluntary private companies had participated. In addition, (Roseno, 2012) describes that the SPED was formally established by the decree number 6,022 on January 22, 2007 as part of the "Aceleração do Crescimento do Governo Federal (PAC 2007-2010)" program, incorporating 3 projects: a) Electronic Fiscal Invoice (NF-e), b) Digital Accounting Record (ECD), and c) Digital Fiscal Record (EFD). (Oller de Mello, et al., 2009) comment that by September 15, 2006, as a result of the pilot, they began to use legally valid electronic invoice. In April 2008 they began with the expansion stage for the mandatory use of the NF-e. Subsequently, as indicated by (Oller de Mello, et al., 2009), thanks to the success achieved by the NF-e, in October 2006 a new public policy for electronic tax oriented to the transport sector, known as "Conhecimento Transport Eletrônico (CT-e)", has started. The new legislation was approved in a record time in October 2007, and a pilot project with 2 voluntary states and 43 private companies has been launched. Thanks to the replication of standards and best practices proposed for the NF-e, by March 2009 the first transport companies start issuing legally valid CT-e, and by 2010 is extended to the whole country. As evidenced in (Mello, 2014), the successful implementation of the electronic invoices (NF-e) put Brazil's system as one of the most advanced systems of tax statements.

7. MODEL APPLICATION

Based on the gathered information and the analysis of the situation in Costa Rica, comparing it to the case of Brazil, we proceed to create a model of actors where the feasibility of the solution in the current state is calculated, and scenarios will be proposed to increase it. Following the typology described by (Subirats, et al., 2008) which ranks stakeholders in Public, Private, Objective and Beneficiaries, and the assessment of actors model described in (Cortés-Morales, 2015) we proceed to an analysis of the main actors present in the Costa Rican national context (Table 1).

Table 1. Identified Actors

Type	Entity	Identified Stakeholders
Public	Costa Rica's Presidency	Luis Guillermo Solís Rivera
	Treasury House	Helio Fallas Venegas
	Central Bank of Costa Rica	BCCR Board
Objective	Taxpayers in Favor	It is expected to be mostly large taxpayers who saw this initiative as an opportunity to decrease operating costs
	Taxpayers Against	The big evaders and freelance workers, who with the control increases will be forced to report all transactions and thus see an increase in their payable taxes
Beneficiaries	Treasury House Employees	Set of officials who benefit by having better tools for tax control
	Business Consultants and Developers	Group comprised of consulting firms, developers and implementers of electronic invoice that would potentially increase their income by an expansion of the market segment
	Citizens	There will be greater transparency and better tax collection, which will benefit the government's finances and allowing it to implement public policies for citizenship

We proceed to perform a multidimensional analysis to determine the power of veto, which is the resources that an actor has at a given time and their relative importance; and the level of support, which measures the level of support based on the resources that an actor brings in favor or against public policy. In order to calculate the power of veto, resources are categorized into four types: a) Institutional, b) Economic, c) Public Recognition, and d) Media. Each of these categories are assigned a weight according to the level of importance for the solution formulation as is described in (Cortés Morales, 2016). Table 2 shows the values assigned to these categories. Similarly, the level of support, which is categorized into two types: a) Positioning and b) Actions, as is shown in Table 3.

Table 2. Veto Power Factors Weight

Parameter	Value
Institutional	45%
Economic	35%
Public Recognition	15%
Media	5%

Table 3. Support Level Factors Weight

Parameter	Value
Positioning	30%
Actions	70%

Once the weights of the veto power and level of support factors are identified, each actor is evaluated to determine the individual impact for the proposed solution. Table 4 and Table 5 are the result of the veto power and the level of support for both Mr. Solis, President of Costa Rica, and Mr. Fallas, Minister of the Treasury House; two of the key actors involved.

Table 4. Current Luis Guillermo Solís Rivera Impact

Type	Parameter	Value
Veto Power	Institutional	0.75
	Economic	0.75
	Public Recognition	0.60
	Media	1.00
	Total	*0.740*
Level of Support	Positioning	0.50
	Actions	0.25
	Total	*0.325*

Table 5. Current Helio Fallas Venegas Impact

Type	Parameter	Value
Veto Power	Institutional	1.00
	Economic	0.50
	Public Recognition	0.70
	Media	0.50
	Total	*0.755*
Level of Support	Positioning	0.75
	Actions	0.75
	Total	*0.750*

The calculation of the veto power for each actor was obtained using (1), which considers the weight of each parameter and the ability of each stakeholder on it. While the level of support was calculated using the same logic, but based on the position and actions taken. To set the feasibility of the solution we used formula described in (2), where the veto powers of each actor are contemplated, as well as the level of support they have provided for the promotion of electronic invoicing in Costa Rica, then resulting in a feasibility 0.5163 for the solution.

$$power = \frac{\sum_{i=1}^{n} FactorWeight_i \times PlayerFactorValue_i}{\sum_{i=1}^{n} FactorWeight_i} \quad (1)$$

$$feasibility = \frac{\sum_{i=1}^{n} Support_i \times Veto_i^{Options}}{\sum_{i=1}^{n} Veto_i} \quad (2)$$

The result shows that the feasibility of the solution is average, representing the national situation. Although it is true that the subject has been part of the agenda of the Treasury House and there have been some efforts to establish electronic invoicing, they have not been successful. One of the main reasons for these failures is the lack of political commitment to promote and construct the solution. Having analyzed the set of actors identified in the current Costa Rican context, a projection is created about what would be the ideal environment for the establishment and implementation of the project to equip the Tax Department of a mechanism to improve tax collection in the country. To do that, the relevant actors where re-assessed, assuming they have the level of resources required to promote the implementation. Table 6 and Table 7 shows the result obtained with certain key capabilities enhanced for the President and the Minister (using Brazil's reference in the resources needed for a feasible solution). Also in Figure 1 shows the comparison for all involved stakeholders before and after the modification.

Table 6. Projected Luis Guillermo Solís Rivera Impact

Type	Parameter	Value
Veto Power	Institutional	0.75
	Economic	0.75
	Public Recognition	0.75
	Media	1.00
	Total	*0.762*

Table 7. Projected Helio Fallas Venegas Impact

Type	Parameter	Value
Veto Power	Institutional	1.00
	Economic	1.00
	Public Recognition	0.70
	Media	1.00
	Total	*0.955*
Level of Support	Positioning	1.00
	Actions	1.00
	Total	*1.000*

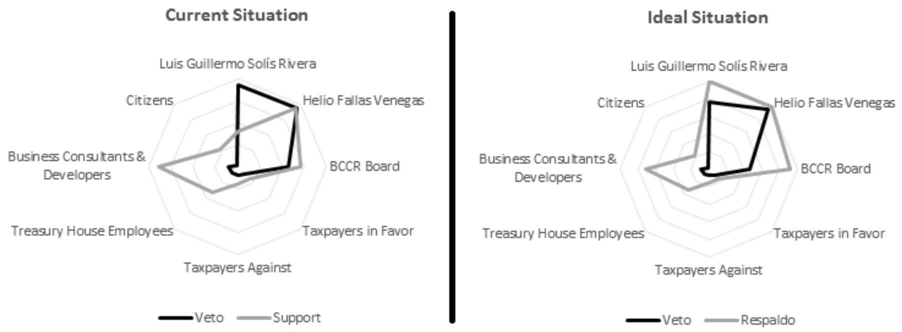

Figure 1. Current Situation vs. Ideal Situation

The President of Costa Rica, Mr. Luis Guillermo Solis Rivera, should ideally give full support to the initiative, reflected in the increase of the Positioning and Actions factors. In addition, is needed an increase in its public recognition, since its current valuation as public figure is not ideal, so he can count on greater support to positively promote the solution in the public debate (for example, to fight corruption or to have funding for social programs). The Minister of the Treasure House, Mr. Helio Fallas, must strengthen his support to the electronic invoicing, making it a priority for his administration and securing the financial resources required for the implementation. It is important to note that he is the person called to take the leading role as a sponsor of the project, and should remove barriers. After the adjustments, the feasibility formula (2) is applied again, where are contemplated: a) the veto powers of each actor, and b) the level of support they could provide; obtaining a higher feasibility of 0.8964 for the solution.

8. CONCLUSION

From this research, we can describe the following set of recommendations to achieve the implementation of the electronic invoice in Costa Rica. First is to follow good practices for the analysis and adaptation of successful models in similar areas. A clear example is the case of the implementation of the electronic invoicing in Brazil, who sought to replicate the success of Chile, learning from its model, execution processes, and seeking opportunities for improvement and adjustment to the Brazilian reality. That is why Costa Rica should observe Brazil, Chile and other countries as best practices references, in order to seek the adoption of a proved solution, instead of investing resources in exploring uncertain solutions. Hence, Costa Rica should encourage the creation of international partnerships to achieve the interaction between Costa Rica's project team and representatives of studies cases that can provide advice on different dimensions. To launch the initiative it is not required the involvement of the Government's Legislative Branch in creating a legal framework to support it, since there is already the necessary institutional framework that gives the authority to the Treasury House, specifically the Tax Department. Therefore, Costa Rica must work on the creation of a centralized government system, to subsequently determine their progressive mandatory adoption among different commercial entities operating in the country; providing the necessary mechanisms for widespread and unrestricted access. From the analysis of actors, it is appreciated that there are no limitations for the implementation of the solution. Main factors that have avoided its implementation is the lack of political commitment. On the other hand, there is widespread concern in the population with respect to the corruption problems through tax evasion. Hence the Minister of the Treasury House, with the support of the President, should take advantage of recent scandals, and the need for a change in the fiscal situation of the country, to strongly promote the initiative. Here is evident the importance of creating a plan for the short, medium and long term, that includes the study and adaptation of successful models, the technical implementation, the necessary contingencies to ensure taxpayers widespread access, as well as the development of a progressive mandatory adoption, consistent with government and industry capabilities, to ensure acceptance of the electronic invoice.

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CAR APP'S PERSUASIVE DESIGN PRINCIPLES AND BEHAVIOR CHANGE*

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ABSTRACT

The emphasis of this study lies in behavior change after using car apps that assist users in using their vehicles and establishing a process for examining the interrelationship between car app's persuasive characteristics and behavior change. A categorizing method was developed and 697 car apps were investigated and classified into eight categories. Meanwhile, an evaluation guideline was developed and nine persuasive design characteristics were found to be popular used. A quasi-experiment was conducted and a behavior change evaluation process was developed. 109 participants were recruited and asked to use a car app for two weeks. The results indicate that participants clearly perceived eight persuasive design principles and four types of behavior change were found. The participants in four behavior change groups showed different perception levels for eight persuasive design principles. Our pioneer work has contributed to help designers and automakers to develop more effective and more persuasive car apps.

KEYWORDS

Persuasion, Persuasive technology, Persuasive design principles, Behavior change, Car apps, Car-related mobile apps

1. INTRODUCTION

Car-related mobile applications, which have accompanied the explosive growth of smart cars and smart mobile devices, are broadly used as brand-new medium and paid attention by app designers and automakers. However, it still not causes academia attentions. Based on a lot of researches about mobile application and in-car applications, we give a generalization about a car-related mobile application (hereafter shorted as "car app") as a basically little, self-contained programs used for enhancing existing car using or managing functionality and changing complicated car using behaviors into more user-friendly ones. Until May 6, 2016 over 3,973,284 apps from both Android Platform (Google Play) and iOS platform (Apple Store) are approved. But based on our one-year investigation, less than 1% mobile apps are about car using or car management. Most of the car apps have a few downloads and low review points due to poor function design, poor persuasive design, system errors, and etc. It is hard to bring profits for car developers. Another problem is that user acceptance and user intention about car apps are not clear enough for car app designers. Basically, a profitable car app should at least have the characteristic of "network externality". But based on our investigation, most of them are lack of network effet. The most urgent issue is to find out what kinds of design principles have effect on user intention. In other words, car app designers and automakers want to find out how to design effective and persuasive car apps that may attract user's interest or persuade them to continuous use.

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This paper focuses on five research questions: First, what is the development status of car apps? Second, what is the persuasive design status of car apps? Third, is it possible for car user to perceive the persuasiveness of car apps? Fourth, what kind of behavior change can be found after using a car app? Finally, is it possible for car users with different types of behavior change have different perceptions about car app's persuasive design features? The purpose of this study is to provide insight into the current states of persuasive design in car apps and to confirm the relationship between car app's persuasive design features and behavior change. The results can be useful to automakers and independent app designers (hereafter shorted as "app developers") when designing persuasive apps.

This study is conducted in four research stages as follows. First, after one-year investigation, about seven hundred car apps were found and checked from two different app distribution platforms - Apple App Store and Google Play. The investigation focuses on two aspects. One is about car app's function and utility. A categorizing method was developed to classify these car apps into eight different categories. Another aspect focuses on confirming car app's persuasive design features. Based on persuasive technology theory, an evaluation guideline was made to investigate these car apps' persuasive design characteristics. According to the guideline, about nine characteristics were confirmed among these car apps. Second, empirical study methods are rarely involved in most of the existing studies about persuasive design. Furthermore, most of the existing studies are lack of empirical data and feasibility, especially for car apps. Therefore, based on literature review, only a few measurement items were collected from existing studies, while most of the other measurement items were directly developed. After several rounds of expert screening, all measurement items that related to the nine persuasive characteristics were developed. Third, an experimental study process was designed to confirm whether subject's car using behaviors were changed after using a test app. Based on Fogg's Behavior Change Wizard, an evaluation process was designed to check 109 participant's behavior change after two weeks. Four types of behavior change were found. Finally, in order to confirm the relationship between behavior change and persuasive design characteristics, the data collected from the experimental study were further analyzed. The results show that there were significant differences about persuasive design perceptions among four types of behavior change groups.

2. RELATED WORKS

Several prior studies have examined types of behavior change and persuasive design principles by using experimental methods. The review of the prior studies highlights three issues. First, the theoretical interpretation of behavior change after using mobile apps is not clear. Most previous studies highlight the behavior change after some experiments, for example, about weight lose or gain weight after eating some kinds of food, etc. Most of them did not focus on behavior change in mobile apps. Second, the theoretical interpretation of persuasive design for mobile apps that caused behavior change is not explained. In addition, some studies about car apps rarely involve this topic. Third, extant studies typically restrict their empirical research methodologies to surveys or some controlled laboratory experiments, so that it is unclear whether their findings are robust for actual commercial contexts. Only a few studies provided some effective empirical studies about the persuasive design principles, but they did not look hard enough for its concrete behavior change results. This means these studies cannot prove those persuasive design principles to be a good way to make users change their behavior.

Persuasive technology is defined as any interactive technical system designed for the purpose of changing people's attitudes or behaviors [Fogg, 2003]. Persuasive technology, as a kind of interactive information technology, is a fast-growing research topic, especially for mobile app design. In the past, behavioral psychology researchers and mobile app designers had to make guesses at solutions for changing behavior. However, most of their attempts failed. The Behavior Wizard developed by B.J. Fogg is useful as a guide to supply a solution in order to confirm a user's behavior changing type.

Some scholars and researchers also focus on identifying distinct persuasive software features in order to confirm and evaluate the significance of persuasive systems and behavior change support systems [Oinas-Kukkonen, 2012]. Actually, Fogg has provided a widely utilized framework to help developers to understand the persuasive technology [Fogg, 2003]. However, it cannot be used directly to evaluate the persuasive system design or even as a guide to lead developers to follow some effective principles to design a system with persuasion [Harjumaa and Oinas-Kukkonen, 2009]. To evaluate a system or a mobile app, 28 principles that belong to four main categories should be followed. “Primary Task Support” category contains the principles of reduction, tunneling, tailoring, personalization, self-monitoring, simulation, and rehearsal. “Dialogue Support” category includes the principles of praise, rewards, reminders, suggestion, similarity, liking, and social role. System Credibility Support” category is consisted with the principles of trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsement, and verifiability. “Social Support” category includes social learning, social comparison, normative influence, social facilitation, cooperation, competition, and recognition. However, most persuasive system design principles have not been evaluated by empirical research.

Persuasive technology comes into the domain of an interactive information technology combined with behavioral psychology. It focuses on the interaction between humans and intelligent devices, such as human-computer, human-smartphone, etc. [Fogg, 1998, 2010; Oinas-Kukkonen et al. 2008, 2009]. In a sense, persuasive technology can be considered as some kind of design with the intent to persuade people to change their attitudes or behaviors [Lockton et al. 2008]. Oinas-Kukkonen and Harjumaa (2008, 2009) classified the persuasive technologies from another perceptive, which is about whether the persuasive technologies can change user attitudes or behaviors through direct interaction or as a mediating role. Persuasive technologies nowadays take the form of apps or websites that use new capabilities of devices to change user behavior rather than traditional ways that use information, incentives, and even coercion. Persuasive technology can be found in mobile apps or websites with behavior-oriented designs like Amazon and Facebook, which can persuades users to buy more often or stay logged in. Many mobile apps, such as some health-oriented apps that incentivize weight loss and help to manage addictions and other mental health issues. Developers design their products by analyzing and evaluating the content, using established psychological research theories and methods. Most of these products or services have used persuasive design that focuses on making users feel comfortable in making decisions and helping them act on those decisions. For instance, in the automotive area, an insurance company’s “Snapshot” usage-based program can monitor user driving via data from the car data port. Users try their best to drive safer, and then save money on the insurance fee.

The research for behavior change is an important research topic about what caused behavior change for both researchers and software developers. Fogg developed the “Behavior Wizard” to help designers identify specific types of behavior targets, confirm behavior change types, and match them to relevant solutions. It is described as a matrix of 15 types of behavior change. The horizontal axis segments behaviors into five “Flavors” which use five different colors to represent five different behaviors: do a new behavior that is unfamiliar (Green), do a familiar behavior (Blue), increase behavior intensity or duration (Purple), decrease behavior intensity or duration (Gray), and stop doing a behavior (Black). The vertical axis represents behavior’s durations: one time (Dot), span of time (Span), or ongoing (Path). With the 15 behavior types, it can isolate, identify and clarify the target behavior and distinguish it from others. It can highlight the concepts and solutions related to target behavior, which may help to create a persuasive experience [Fogg & Hreha, 2010].

3. RESEARCH APPROACH

The purpose of this study is to evaluate participants with different types of behavior change have different perceiving level for the persuasive design characteristics of car apps. Therefore, an investigation was used to find out the current status of car apps and to check the persuasive design characteristics of current car apps. A quasi-experiment was developed to estimate user’s behavior change, to find out user’s perception for the persuasive design characteristics of car apps, and to check the perception difference for persuasive effectiveness among different behavior change groups.

3.1 Study One: Categorizing for Car Apps & Persuasive Design Evaluation

Investigations for car apps spanned October 2013 till March 2015 in two rounds. About a thousand mobile apps were collected and analyzed by searching with keywords, such as “car”, “locating”, “driving”, “navigation”, “maintenance”, etc. Based on car app’s functionality, utility, and features, a categorizing method for car apps was developed. This method was tested in two rounds by using the method of inter-rater reliability. The results of round one and round two show that the Cohen’s Kappa are 0.886 and 0.828, which means Cohen's Kappa basically estimate that an agreement level beyond chance at 88.6% and 82.8%. The categorizing method is proved to be reliable. After repeated siftings, a total of 697 available car apps (not include car game apps, cartoons, etc.) are classified into eight different categories: news and basic information about car (C-1), buying and selling (C-2), driver's communication (C-3), location service (C-4), safe driving service (C-5), A/S and maintenance management (C-6), renting service (C-7), and car expenses monitoring (C-8). Table 1 shows the summarized results. The investigation shows that most of the car app developers focus on designing car apps in four categories: car news and basic information (28%), locating service (23%), safe driving service (12%), car renting service (15%). However, their system design is too homogeneous, especially much similar in main functions or operation interface. Only a few apps are designed to be comprehensive and contain functions from two or more categories.

Furthermore, based on prior research, a "Car App's Persuasive Design Guideline" was developed to investigate 679 car apps' persuasive design characteristics [Zhang et al. 2016]. For example, a car app "Mudu Parking", 12 characteristics were found. In this app, "Coupon can be downloaded and bonus points can be used as money" can be confirmed as the persuasive design characteristics of "Rewards". Furthermore, "Use guide, question emails, or Kakao Talk to help users" can be considered as the characteristics of "Suggestion" [Zhang et al. 2016]. The result of Fleiss' Kappa (k=0.782) proved this evaluation method to be useful and reliable. It was found that nine persuasive design characteristics observed in current car apps are popularly used by app developers. They are: self-monitoring, reduction, personalization, reminder, suggestion, trustworthiness, real-world feel, expertise, and verifiability. [Zhang et al. 2016].

3.2 Study Two: Experimental Research Design

Based on our investigation, not all of the persuasive system design principles are used in the current car app's design process. Actually, no existing empirical study about persuasive design is related to mobile apps, especially for car apps. Smartphone and vehicle are two of the indispensable devices of our daily lives, the trend is that in-car apps and car apps are tightly coupled with each other and mutually complement each other. Therefore, how to design a more persuasive car app that can effectively change a user's traditional car using behaviors or managing behaviors should be a pressing and important research topic for app developers and academic researchers. The purpose of this study is to check whether a car user's perception level of the car app's persuasive features is different among different types of behavior change. The main problem is to find out whether subject's car using or managing behavior will change after using a car app.

An experimental study is designed to confirm whether subject's car using behavior will be changed after using a car app for driving or managing the vehicle. This process is compiled to measure subjects' behavior change types after a two-week test. The experiment subjects are drivers who also have a smartphone who can use a car freely or own a car. A parking app (Mudu Parking) from the locating service category is selected as an experimental object, hereinafter referred to as app-A. In this paper, the reason for choosing this app is not only its download amount but also the average rating score in both Apple App Store and Google Play are higher than other parking apps in Korea app market. Furthermore, it represents all of the nine common persuasive design features. This experiment will be performed in the Republic of Korea and it contains three stages. In the pre-test, we show a PPT to participants about test app and make sure all participants clearly understand what the app is used for. For those who want to download and make a trial for App-A will be our experiment participants. After a few minutes for trail, we ask participants to answer the pre-test questionnaire-A, which contains the questions about App-A and demographic information. We inform the participants to use the test app freely during the test period and record their usage frequency. Two weeks later, in the post-test, we ask the participants to answer the post-test questionnaire. The post-test questionnaire contains a post-test experiment questionnaire (A) and a survey about user perception (B).

3.2.1 Pre-Test Questionnaire Design

In the pre-test questionnaire, after two rounds pilot test, each question is used as a precondition to determine the participant's behavior status before starting the two-week experiment. The question list and the logistic evaluating standard are listed. Based on 15 types of behavior change mentioned by Fogg, this study attempts to make behavior change measurable and observable for researchers additionally. (See Table 1).

Table 1. Pre-test Questions

No.	Questions
Q1	Have you ever used app-A or something similar to app-A while you use or manage your car?
Q2	Have you ever used app-A?
Q3	Please write down all you have ever used car apps that similar to app-A.
Q4	Are you using these kinds of car apps for the past week?
Q5	Please write down the name of app you used last week.
Q6	What's the frequency of using your car app while you use or manage your car?
Q7	Do you think the using frequency that you use these car apps in the past week is more than before?
Q8	How often did you use these kinds of car apps before while you used or managed your car?
Q9	Do you still want to continue to use these kinds of car apps while you use or manage your car?

The pre-test process is mainly used to check out participant's behavior "Flavors" and confirm the usage of test app (App-A) before the test. The pre-test process would show "Green Behavior" (do a new behavior), and "Blue Behavior" (do a familiar behavior) from answers of question 1 (Q1) to question 5 (Q5). The answers from question 1 to question 5 also help to confirm the behavior starting status for "Black Behavior". Before this test, some car users may also have some experience with car apps, especially using app-A. Therefore, question 6 to question 8 show the usage frequency of App-A before the test, which will be used to compare with the usage frequency during the test. The comparison results would show "Gray Behavior" and "Purple Behavior". The other questions are used to help researchers know about the car app usage of participants (See Figure 1).

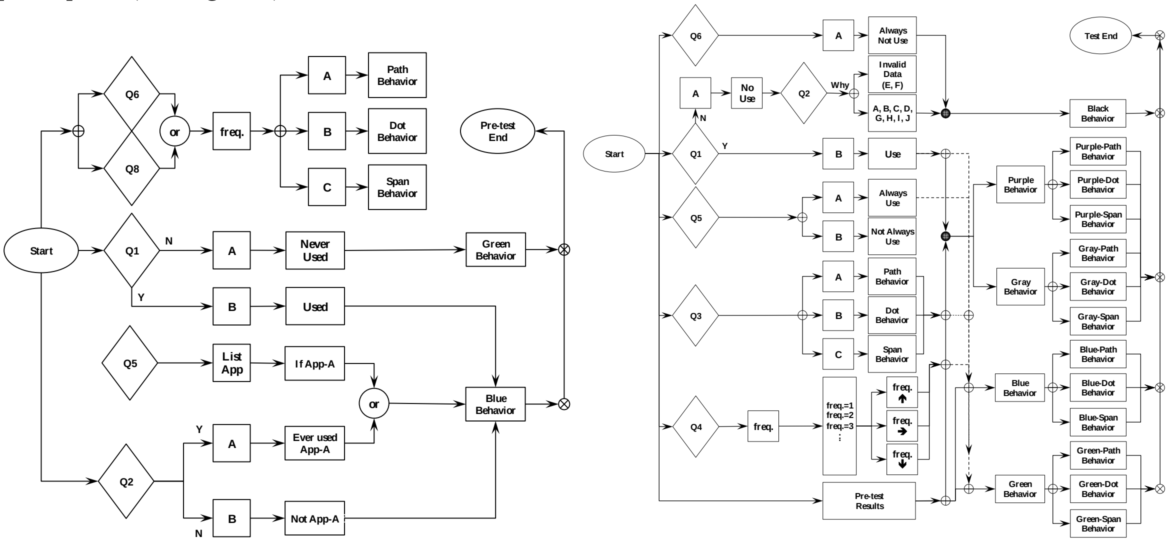

Figure 1. Pre-test & Post-test Evaluation Process

3.2.2 Post-Test Questionnaire Design

Post-test consists of two questionnaires: Post-test Questionnaire A and Post-test Questionnaire B. Questionnaire A is for confirming car user's behavior change. The comparison results between pre-test and post-test could be used to confirm the participant's behavior change status (See Table 2). Questionnaire B is for checking participant's perception about car app's persuasive design. After several times of pilot test, the post-test questionnaire is developed and the answer format is designed with a 7-point Likert scale. It is comprised questions about the usage of the experiment object and questions about persuasive design principles. After going through several rounds of very rigorous process of selection by experts, a simple scale development was compiled. Several measurement items were taken from existing research, but most of the other measurement items were developed directly.

In the post-test evaluation process, the main work is to check out participant's behavior "Duration" and confirm the usage of app-A after the test. The post-test process would show the "Duration" for "Green Behavior", "Blue Behavior", "Purple Behavior", and "Gray Behavior" from answers of question 1 to question 5. The answers of question 2 and question 5 also help to confirm the "Black Behavior". The other questions are used to help researchers know about the future user intention. Several times of pilot test for the whole experimental process were also performed. All the experiment process is proved to be available. (See Figure 1).

Table 2. Post-Test Questions

No.	Questions
Q1	In the last two weeks, did you use app-A when its functions were needed while you used or managed your car?
Q2	Please write down the reason that you didn't use app-A during the test.
Q3	How often have you used app-A while you use your car during the previous two weeks?
Q4	Please write down the daily usage frequency over the past two weeks.
Q5	In the last two weeks, did you have a situation where you didn't use app-A when its functions were needed while you drove or managed your car?
Q6	In the last two weeks, what's the frequency that you didn't use app-A when its functions were needed while you drove or managed your car?
Q7	Do you still want to continue using app-A after this test?
Q8	Why you don't want to continue using app-A after this test?

3.2.3 Behavior Change Evaluation Process

Based on this experiment design method, the following evaluation rules were followed to estimate participant's behavior change type. For example, "Q1→B" means test question "1", "→" means "to choose", "B" means the answer. The detail descriptions for 15 types of behavior change have been developed but only one examples of evaluation process will be listed in this paper because of the page limitation (See Table 3).

Table 3. Example for Evaluation Process

Status	Test Question	Flavor / Duration Behavior	Behavior Change Type
Pre-test	Q1→B or {Q2→A or Q5→App-A}	Blue Behavior	Blue-Span Behavior
Post-test	Q1→B {Q3→C; Q4 Freq.=2 or 2↑}	Span Behavior	

4. DATA ANALYSIS AND RESULT

This experiment was started on May 17th, 2015 and four round tests were performed until June 4th, 2015. Total 109 participants took part in this test. They were asked to respond to the questionnaires during the post-test. 95 valid data were collected, excluding 14 invalid data. About 51.3% participants came from a company and it's research center, 11.9% participants came from two universities, and about 36.7% data was collected from a Presbyterian church (30.3% homemakers and 6.4% self-employed persons). Among these participants, 71.56% participants are over age 35 and all of the participants have over undergraduate education. About 84.4% participants have more than three years smartphone using experience and over 91.75% participants have more than two years driving experience. About 61.47% participants use smartphone every day less than one hour and 14.68% use 2-4 hours. 96.33% participants drive about 0.5- 2 hours everyday and over 52.29% participants drive in metropolitan cities.

By comparing the results of pre-test and post-test, four types of behavior change were discovered: "Green-Dot" (22 participants), "Green-Span" (41 participants), "Blue-Span" (19 participants), and "Black Behavior" (13 participants). "Green-Dot" behavior means that using app-A to drive or manage their cars is a new behavior for the participant, and this new behavior is only carried out once in a certain period. "Green-Span" behavior means that using app-A to use or manage their car is a new behavior but performed more than one time, but not always during the test. "Blue-Span" behavior means it is not the first time for a participant to use App-A and the usage frequency is more than one time but not always during the whole test period.

In the post-test process, participants were also asked to answer Questionnaire B, which was about user perception for car app's persuasive design. Total 95 available data was analyzed. Exploratory factor analysis and credibility test were used to inspect and deal with the collected data. The result of factor analysis shows that all the items are factored into their desired group, such as reminder (0.779), self-monitoring (0.926), real-world feel (0.936), expertise (0.809), suggestion (0.806), and trustworthiness (0.894), only except for reduction. The Cronbach's alpha values for all six factors are over 0.7, which means these factors appear to have good reliability. The results of one sample t-test show that participants can perceive the persuasive design characteristics of App-A during the test. Questionnaire B uses 7-point Likert Scale to allow participants to value their persuasiveness perceptions from "Strongly disagree" to "Strongly agree". For the variables of "Reminder", "Self-monitoring", "Real-world feel", "Expertise", "Suggestion", and "Trustworthiness", if their population means are more than "4" (neither agree nor disagree), it means participants can perceive the persuasive design principles of App-A. For the variables of "Verifiability" and "Personalization", each variable have seven questions and participants should check "Yes" or "No" or "I don't know". Therefore, if one question of each variable is checked as "Yes", it can be considered that participant can perceive this persuasive design principle. In other words, for variables of "Verifiability" and "Personalization", the population mean should more than "0".

The results of one sample t-test show that all of the p values are significant. That means participants can perceive the persuasive design characteristics of App-A during the test. The research question four can be confirmed. Analysis of variance (ANOVA) was used to examine whether there are differences of participant's perceptions for persuasiveness among different types of behavior change. Based on Table 4, the mean plot for the eight factors can be distinguished as five different patterns.

Table 4. Exploratory Factor Analysis and Reliability

	G1	G2	G3	G4	Sig.	Group Diff.	Pattern
Reminder	4.11(0.99)	5.70(0.89)	5.96(0.73)	3.74(0.64)	***	2, 3 > 1, 4	P1
Self-monitoring	3.58(0.90)	6.17(0.67)	5.92(0.46)	2.90(0.40)	***	2, 3 > 1 > 4	P2
Real-world feel	3.89(1.24)	5.28(1.52)	5.26(1.22)	2.23(0.95)	***	2, 3 > 1 > 4	P2
Expertise	4.02(0.79)	5.59(0.92)	5.40(1.02)	3.64(0.66)	***	2, 3 > 1, 4	P1
Suggestion	3.18(1.02)	5.76(1.03)	4.95(1.20)	3.04(0.88)	***	2 > 3 > 1, 4	P3
Trustworthiness	4.70(0.66)	5.96(1.14)	5.68(0.63)	2.65(1.05)	***	2, 3 > 1 > 4	P2
Verifiability	1.50(0.96)	2.15(0.36)	3.42(0.84)	1.08(0.28)	***	3 > 2 > 1, 4	P4
Personalization	3.23(0.61)	5.39(0.49)	6.47(0.51)	2.54(0.78)	***	3 > 2 > 1 > 4	P5

For Pattern "P1", which means car app users who belong to behavior change group "Green-Span" (G2) can perceive more persuasive design features – "reminder" and "expertise" – than the "Green-Dot" (G1) group and "Black-Path" (G4) group. The same is true for "Blue-Span" (G3). Pattern "P2" describes design features "self-monitoring", "real-world feel", and "trustworthiness". The common characteristic of this pattern is that participants in "Green-Span" and "Blue-Span" can perceive more persuasion than "Green-Dot". Furthermore, participants in "Green-Dot" can perceive more persuasion than "Black Behavior". Pattern "P3" describes factor "suggestion". Participants in "Green-Span" can perceive more persuasion than "Blue-Span". Participants in "Blue-Span" can perceive more persuasion than "Green-Dot" and "Black Behavior". However, there are no significant differences between participants in "Green-Dot" and "Black Behavior". Pattern "P4" describes factor "verifiability". Participants in "Blue-Span" can perceive more persuasion than "Green-Span". Participants in "Green-Span" can perceive more persuasion than "Green-Dot" and "Black Behavior". However, there are no significant differences between participants in "Green-Dot" and "Black Behavior". Pattern "P5" refers to factor "Personalization". Participants in four groups can perceive significantly different persuasive effectiveness for this factor (See Table 4).

5. DISCUSSION & CONCLUSION

After a long-term research, this paper finds an approach for the research topic and identifies the results. The first is to classify car apps into eight categories. After over 17 months of investigation in the current car app market, 697 car apps were classified into eight categories by using our categorizing method, which is developed by considering car app's functions, utilities, and features. The eight categories are: car news and basic information, buying and selling, car users communication, locating service, safe driving service, A/S and maintenance management, renting service, and car expense monitoring. This categorizing method will help researchers and app developers better understand the developments of the car app market. Second, by using our persuasive design guideline, this paper summarized car app's persuasive design features. Nine features are observed: self-monitoring, reduction, personalization, reminder, suggestion, trustworthiness, real-world feel, expertise, and verifiability. The detailed information has been discussed in prior research papers. Third, this paper observed four types of behavior change after two-weeks test: “Green-Dot”, “Green-Span”, “Blue-Span”, and “Black” behavior change. Although the experiment design process has been logically and objectively designed, the other eleven types of behavior change were not observed. However, it seems to confirm that this experiment process shows validity. The analytical and clinical view of the experimental procedure was proved to be strong and can be used as a reference to further empirical study in this field. Finally, participants can perceive the App-A’s persuasive design characteristics, which included Self-monitoring, Personalization, Reminder, Suggestion, Trustworthiness, Real-world feel, Expertise, and Verifiability. Furthermore, participants in different behavior change group perceived different level of car app’s persuasive design features. It can be distinguished as five different patterns. The exploratory factor analysis checked seven variables and distributed six sets of factors, excluding reduction. They are: reminder, self-monitoring, real-world feel, expertise, suggestion, and trustworthiness. The reliability analysis shows that these factors appear to have good reliability. Furthermore, a one-way ANOVA was performed and the result showed that there were significant differences between each group.

This study attempts to make several contributions to research and practice in the field of persuasive technology and behavior change. Especially, this research is designed to make a systematic approach to integrate persuasive technology with behavior change research. First, this paper is of great significance in discovering the interrelationship between mobile app’s persuasive characteristics, behavior change, no behavior change. The result of this research not only sheds light on the academic field, but also provides guidelines and suggestions to car designers and automakers. The conclusion of this paper can help them follow appropriate persuasive design principles to design more effective and more persuasive apps for car users. It also may increase car-using efficiency and give some useful suggestions for the development of built-in applications. Second, finding a way to distinguish different types of target behaviors adopted from Fogg’s Behavior Wizard and match them with solutions is a much better way to achieve our target behaviors. In order to distinguish car app user target behaviors, this study developed a questionnaire process to discover, distinguish, and confirm different types of behavior change. Most of the correlative papers about Behavior Wizard are not linked to an integrated process that can discover and distinguish all these different types of behavior changes. Most related research only focused on dealing with a certain type of change, but not all of them. This paper puts all of the behavior change types together into one experimental process and tries to find out an integrated way. Therefore, a two steps experiment process that contains a pre-test and post-test were designed and proved to be useful.

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EVALUATING THE QUALITY OF EXPERIENCE OF A SYSTEM FOR ACCESSING EDUCATIONAL OBJECTS IN HEALTH

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ABSTRACT

In the area of primary health care, there is a high demand in Brazil of permanent education and qualification of professionals who work in this field. Besides, nowadays it is a consensus that education can be benefited by the use of mobile devices, especially due to the possibilities of browsing, use and of easy access to different resources. In this context, this article presents an evaluation experience of usability of a mobile system for the access to open educational resources in the area of health. The results point to the construction of a simple application and of to easy access to the objects available and are of utmost importance to their evolution in the aspect of user experience.

KEYWORDS

QoE; e-Health; Application, Education

1. INTRODUCTION

In Brazil, the health services are organized in assistance levels: primary (considered the users' preferential gateway in the health care services network), secondary (specialized services) and tertiary (hospital services). The primary health care is considered to be a set of actions, in the individual and collective spheres, which "comprises the promotion and protection of health, the prevention of dangers, the diagnosis, the treatment, the rehabilitation and the maintenance of health. And it is developed through the exercise of management and sanitary practices, democratic and participatory, in the form of team work, directed to populations from well delimited territories, for which they take sanitary responsibility. It must solve the most frequent and relevant problems in the territory" (Brazil, 2011).

When the technology to support health is applied nationally, it is an efficient way to universalize the access to health and education. The use of mobile applications, for instance, makes it possible promoting distance health actions and aims to: (i) expand the access to educational actions, both to workers and the assisted population, especially by using guidelines available in easy language, with elements of games (Marcos et al., 2006); (ii) increase the efficiency of the attendance in the health units; (iii) minimize the spontaneous demand in the hospitals; (iv) expand the service coverage; (v) enable the screening of medical consultations; (vi) reduce the waiting time between consultations; (vii) and make registrations of the services.

The use of mobile devices as learning tools in health tends to contribute to the reduction of social expenses, because it promotes the educational process in the field, during the professional practice, without the need of removing the professional from his work place for training and qualification (Rowe et al., 2007). This practice has been increasingly seen as a facilitator to the learning process in distance (Kneebone et al., 2008) (Marcos et al., 2006), especially in developing countries, due to the decentralization of the management of health services, which is common in those countries.

It can be noticed, therefore, that the use of mobile devices in health plays an important role in supporting health services, contributing, additionally, to the formation of human resources in the area, and enables the reach of services to countryside areas, by the application of telehealth, especially the tele-education.

Besides the educational aspects, the use of mobile technologies benefits and enhances, in the scope of professional qualification, the convergence of medias, exploring the diversity of resources in mobile devices. Thus, after this introductory section, Section 2 presents correlated works which reinforce the results achieved in the suggested solution. The application to support the offline teaching-learning, is presented in Section 3. Section 4 shows the process used to evaluate the system under criteria of quality and usability. Section 5 presents the results. Section 6 makes final considerations and presents ongoing activities.

2. RELATED WORKS

Some works deal with proposals of architecture and modeling of systems which meet the requirements related to connectivity and access to educational resources, whether via mobile applications or via web. The work of Marcos and other authors (Marcos et al., 2006), for instance, suggests architecture of access to repository of learning objects through mobile devices. Its motivation lies on the necessity of m-learning applications integrated to repositories. However, this architecture has not been fully implemented.

In the perspective of connectivity, Luz and Fonseca (Luz and Fonseca, 2013) presented a support tool to collaborative learning which enables the sending and storage of data between distinct devices even without internet. For this purpose, the concept of ad hoc networks is implanted, in which they depend only on the existence of devices with Wi-Fi boards which work as routers.

The work of Ferreira and Castro (Ferreira and Castro Jr., 2013), in turn, presents questions of synchronism, aiming to enable possible off-line access to educational resources in virtual learning environments. Even though the work does not focus on repositories, its relevance is justified by the architecture proposed, based on synchronization of files and database, designed for situations of instability in internet connection.

Another relevant aspect is the matter of recommendation of materials, strongly approached by Reis and Barrére (Reis and Barrére, 2014). In this work, it is proposed an architecture which enables a professor to provide contents for specific groups, as well as automatic recommendations of content based on characteristics of the user and context information.

It is worth highlighting that the other works bring some interesting applications which emphasize the importance of repositories of educational resources as support instruments to professional qualification. The proposal of the International Database of Educational Objects (Rodrigues et al., 2012) is one of them and brings a repository of educational objects to web environments, whose intent is to cover a unified space of access to materials produced by teaching institutions around the world. We should also emphasize, as a differential, the importance of processes of validation of contents before they are made available.

Another work, strongly related to this article, is the Collection of Educational Resources in Health – ARES (Brazil, 2015), whose aim is to provide educational resources produced by higher education institutions for health professionals. In the context of this article, ARES is used as a subcomponent of the system presented in this paper, which will be presented with details in Section 3 of this article.

3. DESCRIPTION OF THE SYSTEM

It consists of a system, which aims to provide educational resources to the health professionals. Thus, just as in any other service and system of telehealth, there is the need of assuring the authenticity of the available content, because such information directly implies attention to the life and health of patients and population, besides the other legal, ethic, and professional requirements which are common in telehealth in general (Newton, 2014). In addition to these requirements, there is also a demand of monitoring and controlling the access of users' health professionals and allowing that the resources continue available for offline access.

The objectives mentioned and the other functionalities (detailed in this section) meet two main reasons: (i) the requirements of an efficient system to provide educational resources to health professionals and (ii) respect the governmental and institutional requirements of the public entities involved (Brazil, 2010) (Brazil, 2011).

3.1 Description of the Architecture

The architecture of the system is based on a client-server model, with the presence of an intermediate server (MServer), playing a role of processing information for content on lending (present in the Collection of Educational Resources in Health – ARES) as part of the service, in addition to a connection with a federate network of servers (National Registry of Health Professionals – CNPS) to carry out the authentication in different databases. It is important to remember that the servers CNPS and ARES are independent and they are already operating (Brazil, 2015).

For the user, the system presents itself as a mobile application, in which allows the access to a set of educational resources in different basic formats (audio, video, texts, and images) available for download and offline visualization (in mobile stage). Thus, the access and utilization of synchronized resources allows the user a more homogeneous interaction with the structure, where the content presented tends to be the same, with the access being done from different devices. The mobile application was built on Android platform.

3.2 Description of the Functionalities

After requirements elicitation process, validation with health professionals invited, evaluation of visibility and prototyping, the main requirements (essential) and more urgent were prioritized, composing the initial set of functionalities of the point of access and of the system:

User authentication: The user must access the resources of the system and the contents of the application after a federative authentication.

Provision of educational objects: The system provides the educational objects in formats compatible with the mobile devices. The educational objects were, initially, audio, video, text (in PDF), and images.

Offline access: The system must allow the access to the downloaded resources in sessions without internet connection, even though there must be a session time for authentication during the offline use.

Search for educational objects: It must be possible to search for educational objects, both among those which are present online and those already downloaded by the user (in offline sessions). The search may be done by themes, formats, institutions, and others, in addition to search keywords.

Data synchronization: The same user must have access to the downloaded educational objects, even if the access is done from different devices.

Monitoring of access and use: The system must monitor the users' actions, the operation of the device, and the conditions of connection, thus allowing the system of recommendations to be built and improved. Aside from making it possible the production of statistics of use, for the purpose of governmental management in the context of public education and health.

Security of transmitted data (non-functional requirement): The transmitted data related to users, health professionals, both at the moment of authentication and in other transfers of protocol data, must be properly covered and encrypted.

Authenticity of information (non-functional requirement): Any resource which is accessed through the system must be originated from a reliable repository. Thus, it is possible to guarantee that the content presented was properly evaluated and authorized by a competent content-producer team.

3.3 Application's Interface and Use Cases

The application was developed and tested, aside from the main functionalities of the intermediate server, thus putting the system in a functional stage ready for evaluation. The server for tests of authentication with data was left in operation for security reasons. On the "Authentication" screen the user's authentication is done, with the professional's register data. If there is not a register, the user is directed to a registration page.

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Figure 1. “My Archive” Screen

After the authentication, the user starts a session on “My Archive” screen, where he can view the objects already accessed which are present in the device. It is possible to filter the objects by format, run a search among the downloaded materials, filter by themes, see the details of an educational object (such as description, author, date, institution, and file size) and open the resources.

Figure 2. “UNA-SUS Archive” Screen

It is possible to browse to the tab “UNA-SUS Archive” (if there is an internet connection). The browsing can be done among the objects available for download in the repository. It is likewise possible to filter by themes and formats and run a search among the objects in the archive. The details of the objects are presented in this screen.

4. SYSTEM’S EVALUATION PROCESS

The proposal of this research, which has been developed and evolved, is divided into three big stages: conception, development, and evaluation. In order to guarantee the correct execution of the methodology proposed, the management is based on the practices of the PMBOK Guide (Project Management Body of Knowledge) (PMI, 2013) while the process of development of the solution is based on the agile framework Scrum: planning, dynamic and adaptive control based on the execution of the activities proposed.

The conception stage comprised bibliographic review, understanding of the problem to be tackled, gaps identified, and delimitation of the scope. A study of mobile applications applied to health, aiming at defining the proper architecture to the solution was carried out. The requirements were evaluated with the support of health professionals acting in primary healthcare. At the end of this stage, a concept proof was idealized and a prototype of the system was built for the initial and real analysis of the solution proposed.

The development stage comprised the selection of the technologies, platforms, and devices for the modeling of the requirements raised/defined. The intention was to adopt free platforms and technologies, because they favor the dissemination of the use in public services of health, and also facilitate the integration with other systems.

And finally the evaluation stage, which consists of (i) the capture of impression and experience of the users; (ii) the elaboration of simulations and empirical studies. The first part will be described in this article. The second experimental stage, in progress, is where the system proposed will be evaluated integrated to the module of decision, aiming at finding points of improvement and evaluate the impact of the practical application to the remote health and community services in real situations.

With the purpose of capturing the impression and experience of users, a test of usability was planned. Usability is a component of the acceptability of a system. Authors like Nielsen and Sommerville (Sommerville, 2010) (Nielsen, 1993) affirm that the acceptability is a characteristic of the system, which refers, basically, to informing if the system is good enough and meets the specifications of the users. Nielsen (Nielsen, 1993) presents the usability as composed of five components: Easiness of Learning, Easiness of Memorization, Efficiency in use, Few Errors, and Subjective Satisfaction.

The tests of usability for mobile applications are done in laboratories or in field. The tests in laboratory normally use simulators or the device itself. It is important to register that they are less expensive, but in contrast they come up short of the expected, because they do not use the applications in a real environment with access via mobile operator, for instance. In order to verify if the components of usability were met, measurements were defined, such as: time users take to complete the tasks and number of errors in the execution of tasks.

4.1 Capture of Impression and Users Experience

For the evaluation of the application and of the continuous actions, the following indicators were defined: (1) **Learning**: evaluation of the participants profile (players involved) in the use of the technological platform, based on structured surveys and interviews; (2) **Quality of the learning objects**: continuous evaluation of the insertions of technology from the point of view of the population directly favored; (3) **Quality of the system**: evaluation of the system, in such a way to define points of improvement, especially in aspects related to the usability, in other words, if the learning object in the mobile system is easy to be used.

In the evaluation of the application, we considered: a) Performance: aspects related to the minimum requirements of hardware, because of the product lightness; b) Connectivity: it will access repository of scenarios and data of the user for the synchronization and also in offline mode; c) Usability: the scenarios will be for the use in a self-instructional way; d) Portability: capacity of usage in different mobile devices, whether in smartphones or tablets.

The process of capturing of the user's impression and experience happened according to the following flow of activities:

1. Survey Application – Intending to identify the profile of the participant, under aspects related to the use of technologies and social media, the survey, composed of four questions subdivided in up to five items each, was applied.

2. Orientation to the User – The second step was represented by orientation to the user, in order to contextualize the applicability of the system.

3. Execution of The Task List – After the orientation, the user received a list of eight tasks which should be accomplished and in any time questions may be reported.

4. Evaluation of the Test – In this activity, after the accomplishment of the task list, the user was invited to evaluate the way the tests were carried out. Questions related to the easiness of use, disposition and organization of information, layout of the screens presented, nomenclature, messages of the system, and assimilation of the information tackled were numbered. At the end, the user presented a general impression of the test, if it was Interesting or Dull.

5. Suggestion of Improvement and New Requirements – The last activity had the support of the participants, in the sense of suggesting new requirements and improvements to the application.

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4.2 Elaboration of Simulation and Empirical Studies

The set of activities related to the evaluation of the application, in real situation, is in the final stage of planning. The evaluation will be a systemic and a continuous process which will involve: (i) Continuous evaluation of the learning objects produced and of the professionals involved in the execution of the usage scenarios; (ii) Self evaluation of by the students and professionals involved; (iii) Evaluation of the mobile technology used, emphasis on the impact of its use within the educational and assistance contexts.

The team of execution will be responsible for the evaluation of the application, encompassing the analysis of the technologies, as well as the educational resources available and accessed. The evaluation of the system will be done during and after the provision of learning objects, aiming at making adjustments and improvements.

5. RESULTS OF THE EVALUATION

In this section, the results related to the execution of the activities of capture of impression and experience of users will be presented, according to what was presented in the subsection 4.1., items 3 and 4, Execution of the Task List and Evaluation of the Test, respectively.

A set of 7 (seven) professionals, being 2 physicians of family health, 2 professionals in information science, and 3 professionals of information technology participated in the test. The professionals were guided to execute the following tasks:

- Task 01 – Initiate the application;
- Task 02 – Run authentication;
- Task 03 – Identify if there is any video in “My Archive”;
- Task 04 – Download from UNA-SUS an audio object;
- Task 05 – Access additional information of a text object in “My Archive”;
- Task 06 – Play the downloaded audio object;
- Task 07 – Find the theme “Children’s Health” in “UNA-SUS Archive”;
- Task 08 – Filter the theme “Children’s Health” by audio format.

During the execution the time of execution of each task, the errors made in the execution were observed through filming and filling of forms. The average of time spent in the execution of each task is presented in Figure 03. Worst time: 204 seconds (task 4), best time: 54 seconds.

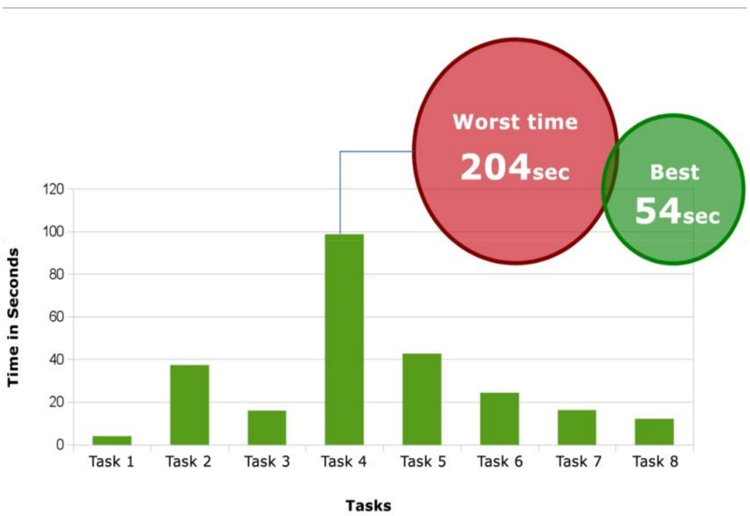

Figure. 3. Average of time spent in the execution of task

Table 1 brings a view of the quantity of errors made by each of the 7 participants in the execution of the tasks.

Table 1. Quantity of errors per execution of tasks by professional

	Tasks							
Users	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
User 1	0	-	0	1	1	0	0	1
User 2	0	-	0	2	1	0	0	0
User 3	0	-	0	1	0	0	0	0
User 4	0	0	0	0	0	0	0	1
User 5	0	1	8	-	5	1	-	-
User 6	0	0	0	3	1	0	0	0
User 7	0	0	0	4	0	0	0	0

Task 4 appears to be the most complex, because it presented the largest number of errors made per participant. In Figure 3 we can observe that task 4 had the longest time of execution, and it may be a consequence of the errors made during the execution. At the end of the accomplishment of the task list, the participants were invited to evaluate the system. The results are presented in Figure 4. Best score: 5, Worst score: 0.

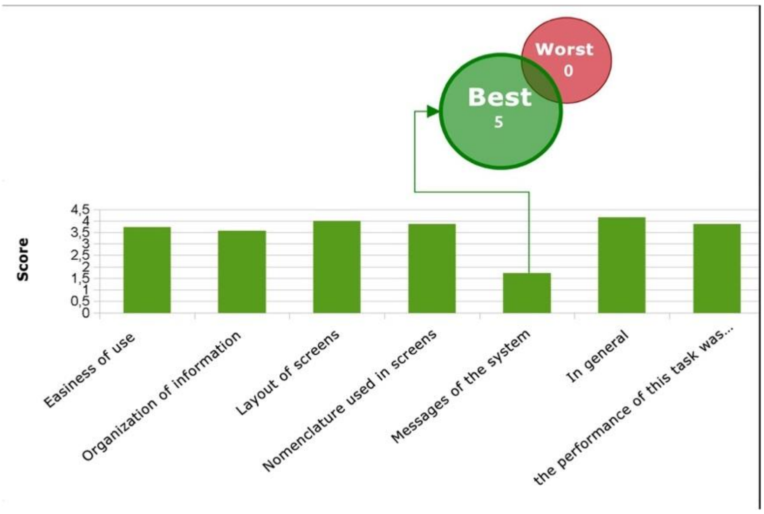

Figure 4. Evaluation of the System by the Participants

In general, the participants emphasized, as positive aspects, (i) the simplicity of the application; (ii) clear and simple layout; (iii) the alternation between “UNA-SUS Archive” and “My Archive”; and (iv) quick view of the themes. Difficulties were observed and reported during the execution of the task list. The most recurring were (i) the functionality “return” did not work; (ii) canceling of download of educational objects/resources; and (iii) exclusion of files initially downloaded to the device.

Based on these results, actions of improvement to the application were defined and are were executed. Especially questions related to (i) the standardization of the search area of educational objects/resources – using Google standard and material design; (iii) the cancelling of the functionality of download; and (iii) the sending of messages of loading objects in the application.

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6. FINAL CONSIDERATIONS AND ONGOING ACTIVITIES

This paper presented an application developed initially for Android system, whose object is providing educational resources and objects, in offline mode, to health professionals. The article brings an account of an experience acquired during the execution of tests of usability of the application in laboratory.

The results obtained were very interesting and contributed greatly to the evaluation of the functionalities and usability of the system. Indeed, new ideas were captured for the improvement of the graphic interface. The simplicity of the application was considered one of the most relevant aspects, reinforcing the idea that browsing must be as simple and intuitive as possible.

The application was evolved according to the results taken from the evaluation presented in this work. Thus, improvements in the interface with the user are were implemented. Besides, the application is going through functional adjustments, the most important one being the possibility of taking courses in offline mode.

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AN EVALUATION OF IPAD AS A LEARNING TOOL IN HIGHER EDUCATION WITHIN A RURAL CATCHMENT: A CASE STUDY AT A SOUTH AFRICAN UNIVERSITY

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ABSTRACT

Since Apple released the iPad in 2010, it has been widely adopted for teaching and learning. Its graphical user interface combined with touch screen features engages users by attracting their attention. However, the level of engagement that would influence learning is not well understood. This case study investigated the use of iPads when engaging students during teaching and learning. A course unit was purposefully selected and 43 students in an extended undergraduate program were given iPads to read, refer, annotate, and access the internet. A structured questionnaire was used to elicit responses from these students. The findings indicated that perceived ease of use ($p<.05$), perceived learning ($p<.01$) and perceived student engagement ($p<.05$) were positively related to learning outcomes. The findings show that the ease of use of iPad, confidence and attention were significant predictors of students' perception that iPad mediated learning.

KEYWORDS

iPad, student, perceived ease of use, instruction, student engagement

1. INTRODUCTION

The world has witnessed a rapid mobile penetration and growth of mobile data including marginalized areas such as Sub-Saharan Africa. According to GSMA Mobile Economy sub-Saharan Africa report, projected 2016 mobile penetration in sub-Saharan Africa would have been 48.7%. An increase in device ownership and data usage was reported due to decreasing cost of mobile devices and an increase in broadband coverage (GSMA the Mobile Economy Report, 2015).

The ability of mobile devices, especially iPad, to share digital content in formats of video, images, voice and text has made it an attractive and appropriate educational delivery tool (Geist, 2011; Henderson &Yellow, 2012; Hutchson, Beschorner & SchmiCrowford, 2012). Students and educators access multimedia content, some in form of eBooks, slides and pdfs from remote servers via wireless network, thus lightning the burden of carrying books to class. Lecturers are able to share soft copies of class notes and other learning material with students (Babnik et al., 2014; Fri-Tic, 2012; Hahn & Bussell, 2012). According to Hughes, (2011), 25 million iPads were sold in the first fourteen months after release of iPad in 2010. This was a remarkable market penetration and the "wow" factor generated by the unprecedented consumer interest and its affordance coupled with it computing power made iPad a preferred mobile device. According to Dahlstrom and Bichsel, (2014), 86% of the students that took part in a survey conducted in 213 institutions with 75,306 responses across 15 countries, indicated that they owned a smartphone while nearly all owned a mobile device.

Research has shown that students used iPad more in class (more than 50% of class time) than laptops (25 % of class time), making iPad a preferred mobile device (Karsenti, 2013). Some researchers have claimed that iPad would revolutionize education (Ferenstein, 2011). Amidst such claims, there are those researchers that have indicated that despite high penetration of mobile devices, the use in learning is not as widespread as the devices themselves (Dahlstrom & Bichsel, 2014). A few students do classwork daily from mobile devices (Wright, 2013), which is relatively small compared to percentage ownership. This is an indication that device ownership and usage in learning is not proportionately related (Chen, Seilhamer, Bennett & Bauer, 2015).

The usage of mobile devices by students is motivated by connectivity to internet, which makes it easy to communicate on social media and access to multimedia content that interests them (Sana, Weston & Cepeda, 2013; Junco, 2011; Smith & Caruso, 2010). While competence in handling a technology has been proven to be a significant predictor of information and communications technology integration in the classroom (Wario & Viljoen, 2015) and students being competent in using mobile devices (Dahlstrom & Bichsel, 2014), does not necessarily mean they are used for learning (Junco, 2012). However, in controlled classroom activities, researchers have reported positive correlations between mobile learning and improved performance (Ostler & Topp, 2013; Rossing, Miller, Coed & Striper, 2012). Others hold the view that they are disruptive in class (Junco, 2012) and should be discouraged. Due to the contradictory views held by researchers, there need to investigate how the students perceive mobile devices as enablers to engage in learning activities; and also how they perceive the device as a learning tool. Research has shown that student acceptance to a technology motivates them to use it more, which is as a result of the way students perceive it and adopt it (Louho, Kallioja & Oittinen, 2006; Yusoff, Zaman & Ahmal, 2011).

Perception is the basic source of knowledge and knowledge is acquired through senses. Philosophers argue that it is often varied, subjective and dependent on the preceptor's powers of reason and emotion, however, researchers use perceptions as basic source of empirical data (Dunn, 2013). This study used student's perceptions as primary source of data to evaluate iPad as a learning tool while the technology acceptance model (TAM) was used to guide the investigation on how the students perceive iPad as a learning tool, and how it enables the student engage actively and collaboratively while undertaking an assigned task. The logit multinomial model was also used for identification of the significant characteristic of the students' that best predicts student's perception to choose iPad as a learning tool.

2. LITERATURE REVIEW

2.1 Mobile Learning

There is no singular definition for mobile learning, however, researchers agree that it encompasses learning mediated by mobile devices used as learning tools (Pegrum, Howitt & striepe, 2013). While definitions use the terms mobile and learning, researchers argue that the term learning means transformation or changes in a person's perceptions, attitudes, cognitive or physical skills after performing a learning activity and that it cannot be 'mobile'. Therefore, the term mobile learning is linguistically misleading (Dichantz, 2001). However, the term is popular and is commonly used and accepted to emphasize the delivery of information that leads to learning. Students are deemed to actively acquire knowledge when they use a mobile computing device to interact with learning objects anytime, anywhere (Ireri & Omwenga, 2014). Mobile learning has a dual aspect in this context, one is the use of mobile learning devices, and the other is the mobility of the student (Sharples, Taylor & Vavoula, 2005). In both cases the learning can take place while a student is mobile or stationary as long as the student is using a hand held computing device. This study considers iPad as a personal learning tool and not an instructional tool, thereby adopting the definition.

The use of iPad and other mobile devices in education has been over praised, however questions continue to be asked, whether they can be used in a Higher Education (HE) environment in a pedagogically sound manner (Oppenheimer, 2003); and if any technology that works outside educational environment, can succeed inside it (Melhuish & Falloon, 2010)? Some researchers argue that, it is due to many challenges facing University level education such as a higher volume of work, large class sizes and demand on student's time and bandwidth that makes universities adopted programs that use technology (Schnackenberg, 2013; Gasparini & Culen, 2012), while others argue that mobile technology is obstructive and is lowering the learning standards since students waste a lot of their time on social media and less time studying (Junco, 2012).

2.1.1 Learning with a Mobile Device (iPad)

Teachers play a significant role in the successful pedagogical integration of teaching technologies in class (Kanseti, 2013), however, learning only occurs when the students engage actively with learning activities (Morf & Weber, 2000; Prince, 2004; Ireri & Omwenga, 2014). Learning is enhanced by the use of technology, which mediates learning (Sharple's et al., 2005). According to researchers, iPad has been tried in class with unprecedented adoption especially in developed countries such as Canada and USA (Etherington, 2013). About 4.5 million students in the USA (Etherington, 2013) and about 10,000 students in Quebec (Kanseti, 2013) use iPad in class.

Mathematics is one of many subjects, which is taught using the iPad (Staats & Robertson, 2014). Staats and Robertson (2014) indicated that students made interesting choices while making videos on iPads of the algebra of inaccessible objects. They were required to take photographs of artwork and do an analysis. As a conclusion of their findings, the way students worked using the iPad could not otherwise have been done to make students understand. In another project, Lewis (2014), taught history using iPad by creating an open theatre called "Place Based Cinema". These were interactive films, animations, and pictures of historical events, which were mapped and made accessible through iPad and Smartphones. In his findings, the digital reading device (iPad), enabled students to customize their reading experience by changing font size using Kindle. The Kindle allowed them to deepen their comprehension by making notes in the text and utilizing the audio-enhanced dictionary. The few research trials of iPad have made some universities like Abilene Christian University provide mobile devices to students and faculty members in order to empower them to use mobile learning as a mode of teaching and learning. At the University of San Francisco, researchers provided faculty members and librarians with iPads and the results indicated that the iPad was valued as a tool for teaching and learning (ACU Connected, 2012).

In all these studies, the success of iPad was mainly due to the ease access of learning content, interactivity between student and content as well as the teachers (Lewis, 2014; Babnik et al., 2013; Hahn & Bussell, 2012). Despite this "wow" factor leading to the adoption of iPad, challenges that are inherent in all mobile devices like transportation of multimedia content alongside scalar data and predictor characteristics of students in using the device are still not fully understood (Alvi et al., 2015). Little is reported on the challenge of introducing iPad in the classroom since its effective pedagogical use and the perceptions of students to use it has not been fully explored. This paper aims to assess students' perception after being introduced to iPad's multi-purpose tablet technology within their learning time. The iPad was chosen because it is a commonly used device in institutions around the world, has advanced technology features and supports many users (King & Bass, 2013).

2.1.2 Technology Acceptance Model

Most studies on introduction of technology revolves around the intention to adopt a particular technology or assessing the usage of it. Literature on user attitude or perception to adopt technology is explained in the Technology Acceptance Model (TAM) (Ramayah & Ignatius, 2005). The TAM has evolved through time, originally developed by Davis, Bagozzi and Warshaw (1992) and subsequently modified by Venkatesh and Davis (1996). They removed an attitude variable from the original model, because attitude did not fully mediate the relationship between perception constructs and behavioral intent. The modified TAM model has been widely applied (Ndubisi et al., 2001; Venkatesh & Morris, 2000; Ramayah, Jantan & Aafacqi, 2003). The model has been used to predict behavioral intent towards the use of information technology. Behavioral intention is a strong predictor of actual behavior according to the theory of Reasoned Action (Fishbein & Ajzen, 1975).

Although some researchers argue that behavioral intention is a subjective norm, which does not directly influence behavioral intent, Davis et al. (1989) states that there is a strong school of thought that supports the opposite. Venkatesh and Davis (1996), found that the subjective norm does significantly influence behavioral intention. This study used the modified TAM model to evaluate the perceived use of iPad in learning and engagement. The external variables were derived from class activities, and were measured on the ability to participate, gain confidence, gain attention and learning.

The modified TAM model by Venkatesh and Davis, (1996) explains the relationships that exist between external variables, perceived usefulness, perceived ease of use, behavioral intention to use and actual usage. External variables are directly related to perceived usefulness and perceived ease of use, perceived ease of use is related to perceived usefulness and behavioral intention to use while behavioral intentional to use is related to actual usage.

2.1.3 The Multinomial Logit Model

The multinomial logit model is a mathematical model used to perform a logistic regression analysis to determine how well the variables predict a student's choices (McFadden, 1973; Agresti, 2002) and to

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determine which characteristic factors are significant enough to explain the choice. The students were faced with the choice of agreeing or disagreeing with the fact that iPad enabled them to learn or not. The logit model is a probability model used popularly in evaluations of perceptions of participants (Park & Choi, 2009), represented mathematically by the formula:- $P(i \backslash z, C, \beta) = e^{z_i \beta} / \sum_{j \epsilon C} e^{z_j \beta}$ where, C={1,2,3,…..j} is a finite choice set; i,j are alternatives in C; z_i is a k-vector of the explanatory variables describing the attributes of alternatives j and or characteristics of the decision maker, which affect the desirability of alternative j; $z=(z_1, z_2, \ldots..z_j)$ representing the attributes of C; and β is a k-vector of taste parameters. $P(i \backslash z, C, \beta)$ is the probability that a randomly selected decision maker faced with choice set C with attributes z, will choose i. Therefore, the taking the natural logs of both side of the equation, the final equation becomes linear and can be represented as:- $\text{logit } P(z_i) = \sum_{i=1}^{k} \beta z_i$.

The leaner characteristics considered in this study were, gender, age, race, confidence, perceived ease of use, perceived engagement (participation), attention, and perceived learning. The choices that the student faced were categorized as agree or disagree that iPad contributed to learning. The β values generated were the coefficients that linearly define the relationships between the choices and student characteristics.

3. METHODOLOGY

The study used a descriptive and interpretive case study method where a survey was conducted to evaluate the Students' Perceptions on use of iPad for Learning after they used iPad to do class work for 14 weeks. The class was sampled randomly amongst first years/extended courses. The students were encouraged to enroll for the class where each student was promised an iPad for the entire semester.

3.1 Procedure

The participants were drawn from an extended program in a faculty of Natural and Agricultural sciences. Students were made aware of the study before they enrolled in the course. Participation was voluntary and students were able to leave the study at any time. All the participants (students =60) who enrolled in the course participated in the study, seven of which took part in the pilot study. Students were issued with iPads and a demonstration on basic iPad procedures was conducted. Students were free to seek help and support from the lecturer who taught the course. After 14 weeks of learning, a questionnaire was given to students. The questionnaire was adapted from works of Streepey, Choe, Miller, Rossing and Stamper (2011) and Diemer, Fernandez, and Streepey (2012). Students rated their learning and engagement while using iPads. Survey responses were classified as Agree or Disagree before data was entered into an SPSS application. Three categories were created perceived ease of use, perceived engagement and perceived learning. Data was analyzed using descriptive statistics, cross tabulations and linear regression binomial logit model to cross examine relationships and perception predictors.

4. RESULTS

Most participants were female (60%) while Blacks (96%) were the majority and the rest Colored (4%). Most participants' (86%) were aged between 19 to 21 years old. Approximately a third (67.3%) of the participants owned a smartphone and 21.2% intended to purchase one.

The level of competence in using a mobile device before exposure to iPad was 51.9%. When participants were asked to describe how likely it was that they would use a handheld mobile computing device for e-learning after the iPad exposure, 44.2% said they were likely while 38.5% said they were extremely likely to use it. Most participants were happy with their experiences, however, 17.3% were not decided whether they would use iPad for learning after the exposure.

A correlation analysis between learning, participation in course activities and connecting to new idea using iPad revealed that iPad as a tool of learning was highly perceived by the participants to be an effective tool that could enhance learning. All Pearson's correlation factors were above .800 at 99% degree of confidence as shown in table 1. The participants indicated that using iPad, was likely to increase collaborative student participation in class activities. They also perceived learning took place while they used iPad. An increase in participation of participants while using iPad in class had a positive correlation (Pearson's correlational value .878) with perceptions of the participants connecting to new ideas and also with the perceptions that learning was taking place (Pearson's correlational value .917). A summary of other analyses on cross tabulations is shown in table 2.

Table 1. Correlation between learning, participation in course activities and connecting to new ideas using iPad

Participant perception	Helped in learning	iPad activities increased Participation in class	Helped connect new ideas
Helped in learning	1		
iPad activities increased participation in class	.917**	1	
Helped connect new ideas	.891**	.878**	1

** P value less than .001

Table 2. Cross tabulation between participants' ease of use, attention, confidence and participation while using an iPad

Cross Tabulation	P-Value	Crammer-V Value
After using iPad versus participation	.000*	.865
After using iPad versus confidence	.001*	.605
Attention versus participation	.010*	.466
Attention versus confidence	.000*	.783

*degree of confidence 95%

From results (Table 2), there existed strong relationships between use of iPad in class and participating in class activities, also between use of iPad in class and participants' confidence, in both cases ($P< .05$), with Crammer's V values .865 and .605 respectively. Crammer's V values are above .5 with its scale of 0 to 1. The results indicate participants gained confidence after using iPad. When participants were asked why they thought they gained confidence when using iPad, they pointed out that it was easy to use. However, there was no significant relationship between attention and participation. Attention in this case was drawn to individual, not group activity. There existed a relationship between gaining attention and confidence irrespective of gender or age ($p< .05$; Crammer's $V > .5$).

The participants' responses on how iPad helped them to solve problems in class were: -

- "I simply google answers or ask my friends by chatting with them";
- "I SMS my teachers"
- "I quickly refer to my notes"
- "I listen to YouTube video clips from other professors".

When asked if they would consider purchasing iPad after the end of the semester, 78.4% were willing, 12% were not decided and 9.6% would not due to high cost of iPad.

A further analysis on the predictors of choices made by the participants on iPad was done using a multinomial logit linear regression analysis and are summarized in table 3. The results revealed that participants' confidence, attention and perceived ease of use of iPad were the characteristics that would best predict the choice of iPad as a learning tool.

Table 3. Summary of the multinomial logit model regression analysis

Helped me to learn the course		B	Wald	Sig.	Exp(B)
Disagree	Gender	4.557	.008	.929	95.265
	Age	.000	.000	1.000	1.000
	Race	.000	.000	.894	1.000
	Confidence	2.023	.000	.949	7.558
	Attention	.000	.000	.893	1.000
	Ease of use	.000	.000	1.000	1.000
	Engagement	.000	.000	.736	1.000
Strongly Agree	Gender	.000	.000	1.000	1.000
	Age	.000	.000	1.000	1.000
	Race	.000	.000	1.000	1.000
	Confidence	12.067	.000	.049*	11.000
	Attention	24.569	.013	.003*	34.010
	Ease of use	45.000	.000	.006*	61.000
	Engagement	.000	.000	.736	1.000

*. The degree of confidence at 95%

The decision to disagree was not predicted by any participant characteristic, which meant there was no distinctive characteristic that featured significantly for them to disagree. However, for them to strongly agree, confidence, attention and ease of use played a significant role in determining the choice to agree that iPad mediated learning.

5. DISCUSSION

The participants perceived iPad as a learning tool, which enabled them to engage in learning activities. These findings are not unique but confirms what other researchers have found out about iPad as learning tool. Fischman and Keller (2011), found out that iPads promoted active learning, collaboration, and student engagement. Perceptions of participants provided the primary data. Fiser, et al. (2010), indicates that human perception is statistically inferred in learning and therefore both perception and learning should not be separated, but be treated together. They argue that perceptions are sensory inputs, which are used by the brain to process what the student experiences as outputs and thus should viewed in a unified manner. In this case, participants' perceptions contributed to and was related to their view that iPad enabled them to build confidence, gain attention and participate in learning activities. The participants became motivated and payed attention in pursuit of a learning goal, a concept that Fischman and Keller (2011) also observed. The study was located in a rural setting with the student population drawn from the rural habitant. Due to high mobile device penetration in rural areas, the participants had previously interacted with a mobile device therefore making it easy to learn how to navigate the iPad features. The responses by the participants on ease of use of iPad for learning confirms that iPad can be introduced successfully in institutions of higher learning including those in rural environments.

The participants' responses on how iPad helped them solve problems gave iPad positive results and made it a potential learning tool for promoting student engagement and collaborative learning. Their responses praised the iPad's collaborative features of communication (Chat), connectivity to internet and access to stored content through shared content.

While the results of this study confirmed that iPad was a suitable device for learning, the excitement of the participants could not be ruled out. Therefore the perceptions expressed by participants should be applied by educators with a pedagogical decision-making and instructional design considerations. When this is done, critics of mobile learning may be pacified. Their argument that mobile devices are disruptive and hinder learning, perhaps is true when students are left to use the devices in class without control. As Kinash, Brand and Mathew (2012) argue, educators should not waste their energy so much with students using their mobile devices in class, the fact that they will go to social media and surf the net, because in their view this is not categorically different from traditional class where students' minds wonder while professors are teaching and use their pen and paper to doodle and write letters during class. Therefore, a lecturer must maintain class control and management in a mobile learning class, just like in a traditional class (Ireri & Omwenga, 2015).

The results from the logit model regression analysis provided indicators why participants preferred iPad as a learning tool. The results are useful to educators that may intend to use mobile technology. The indicators identified as predictors could influence the participants' perceptions to learning. It is therefore, informative to lecturers that building students' confidence, attention and providing user guides on use of instructional technology can aid in achieving learning outcomes.

6. CONCLUSIONS

The students who were the participants' perceived iPad as a good learning tool, which enabled them to engage in learning activities, connect with their classmates, and connect with new ideas. They also perceived that it was easy to use iPad, gained confidence and attention while learning. Most students indicated that they would purchase an iPad after the end of the semester. The results also showed that ease of use, confidence and attention were critical predictors of student's perception to use iPad as a learning tool. This research recommends the use of iPad as an instructional mobile device for higher learning institutions be included in rural catchments areas. Also lecturers intending to use mobile learning need to build students' confidence, attention and provide user guides on use of instructional technology. This will help in achieving learning outcome as designed by the lecturer. Finally, the lecturer must be in control of the class by providing learning activities that engage students with their mobile devices.

7. DIRECTION FOR FURTHER RESEARCH

For effective and useful integration of mobile devices in our classrooms, research needs to continue to examine: institutional and lecturer's readiness to integrate mobile learning in classes, positive and negative pedagogical effects of mobile learning, and the effects of multitasking and knowledge retention.

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TOWARDS A FRAMEWORK TO IMPROVE THE QUALITY OF TEACHING AND LEARNING: CONSCIOUSNESS AND VALIDATION IN COMPUTER ENGINEERING SCIENCE, UCT

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ABSTRACT

This paper aims to propose a framework to improve the quality in teaching and learning in order to develop good practices to train professionals in the career of computer engineering science.
To demonstrate the progress and achievements, our work is based on two principles for the formation of professionals, one based on the model of learning skills and the second on the model of convergence in information technology and communication (ICT) (Bradley, 2005). In this paper, the results are the validation of the graduation profile as part of the process of self-assessment and the internal strategies of the learning community that allowed to achieve the career validation for five years (2015 - 2020).

KEYWORDS

Convergence model, learning and teaching, competences, learning community, ICT, validation

1. INTRODUCTION

A variety of current trends have boosted changes in the way teaching is done (Tobón, 2005; Tobón, 2007). Some of this trends are globalization, the rapid technological development (Crawley et. al., 2007); (Ischinger & Alba, 2009), the new organizational structures of companies, job organization, etc. A lot of international initiatives have resulted in new methodological models and practices that have been incorporated in higher education. The majority of these models are focused on education based on competences. A competence is a visible behavior, skill or aptitude that person shows in a specific context to function effectively and satisfactory (Yániz & Villardón, 2006); (Crawley et. al., 2007).

In order to improve the academic processes, Universidad Católica de Temuco (UCT), for some years, has been boosting a new educational model (Sánchez, 2008). Some of the actions that the university has been taking are to increase the learning results and competencies, supported by the Agreement of Curricular Performance and Harmonization (Convenio de Desempeño y Armonización Curricular or CDAC-UCT1202). The base of this educational model are competences, because it aims to respond to the necessities of the job market and to be on trend with educational models around the world. The university emphasizes an educational model based in generic competences, to give a distinctive feature to the students of the university.

The issue proposed is this paper can be adressed by the two following questions: How to achieve a meaningfull learning? And How to demonstrate that our educational model has quality in the context of IT and psychosocial life?.

The strategies used by teachers are based on innovation, which allows to expand the improvements in human resources for the job market. The university has made several studies concerning the enrollment and the period after graduation of students. The university has also made studies concerning the development of the professional graduated from the Computer Engineering program. We are also working on self-assessments in the following aspects: i) graduation profile, ii) operational mechanism and, iii) self´-regulation of the program.

In the next part of this document the foundation of the educational model of UCT based on competences is showed. In the second section the model of convergence of IT and psychosocial environment. The next part we describe the self-evaluation process and the validation of the program, finally, we show the results and the discussion and the bibliography.

2. FUNDAMENTALS

2.1 Educational Model of UCT

Competence is defined by UCT as: “Knowing how to act, using our own and external resources to solve real problems effectively and ethically” (Sánchez, 2008); (UCT, 2008). There are two kind of competences, generic competences, which are shared among all the programs of the university, and specific competences, which are related to each professional area.

The educational model in our university (Sánchez, 2008) is based on five axes. Therefore, the Engineering Computer program is set in the same way (Herrera et. al., 2009); (Lévano & Herrera, 2012):

1) Model of education based on competences: we are committed to managing the quality of learning, so we have implemented four specific competences that are fundamental for the education and development of the students and ten generic competences stipulated by the university (Herrera et, al., 2009), (UCT, 2008).
2) Significant learning focused on students in cooperation with the ACM models (Lévano & Albornoz, 2016); (CE2008, 2008).
3) Ongoing education: we hope that our students keep studding after they graduate, in post graduate levels that develop and increase the complexity of the development of human resources among the students.
4) Information technologies in the process of learning and teaching: based on what is stipulated in the curriculum, we have intensively incorporated (Sánchez, 2008), (Mellado, Lévano & Herrera, 2015).
5) Humanistic and Christian education: our globalized society demands ethical professionals with robust knowledge about their specific area of study, ability to face problems from different perspectives, and a high capacity for handle a variety of competences or skills. This is done throughout the five years us study in ten generic competences.

These abilities are developed throughout the five years of study by the validation of the generic competences (Herrera et. al., 2009).

2.2 Convergence Model of IT

IT and all its possible applications are interacting with the environment, the functions and processes that can be modeled by the converging circles (Bradley, 2005; Bradley, 2006). The process of social and psychosocial change, as well as IT, and all the concepts and the relationship among them (Bradley, 2005) are critical characteristics of this model. Some examples are: virtual reality —it is the summarization concepts pictured by four circles marked with dotted lines where virtual worlds are globally illustrated— embedded systems (omnipresent or ubiquitous), online and virtual communities, virtual avatars. Also, virtual technologies play an important role for the society (Bradley, 2006). The effects on humans are represented by the circle in the middle part, the individual part is affected by the IT, life environment is affected by the three sub-environments, and the role of life is affected by the three sub-roles. Globalization is affected by its three components values, technology and labor market. However, the individual can also influence the technology, the environment, and his/her own roles and phenomena on the organizational and societal level and the new virtual reality (Bradley, 2006), (See figure 1).

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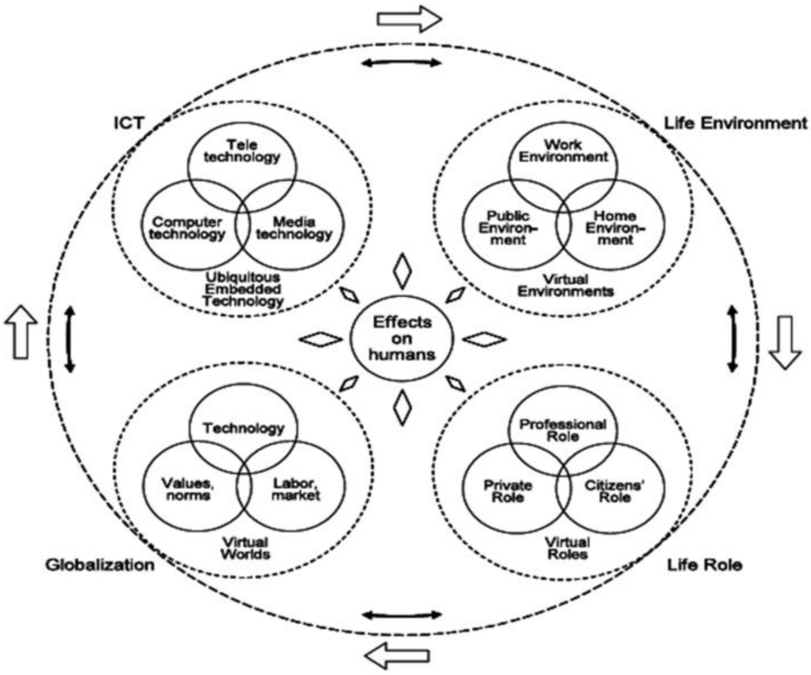

Figure 1. Convergence model on ICT and psychosocial life environment (Bradley, 2005; Bradley, 2006)

3. FRAMEWORK FOR SELF-ASSESSMENT AND VALIDATION

The foregoing process for validation began on march, 2014. We gather the information to make the self-assessment (Lévano et. al., 2014) concerning the graduation profile, and operation and regulation mechanisms. This work was completed in six months and then, the Directorate General of Institutional Management (in Spanish Dirección General de Gestión Institucional or DGGI) took three more months to make a review in figure 2. The stages of the process of self-assessment are showed. They include: induction, results of the application of surveys, self-assessment of the graduation profile, self-assessment of the application of the operation and regulation mechanisms, and development of improvement plan.

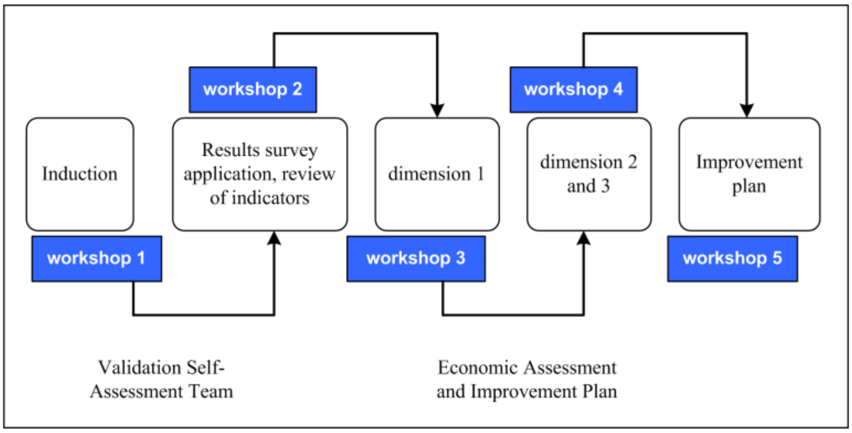

Figure 2. The stages of the process of self-assessment

Aspects influencing validation

- Creating a graduation profile based on the competences and the aspects stipulated by UCT.
- Amount of students graduated from the university currently working and employability rate of 90% after three months of graduation.
- Having a Learning Resource Center and an Innovation Center Teaching as key mechanisms in the management and support of the issue of competences.
- Having a portfolio of employees in the Araucanía and Santiago regions.
- Having good infrastructure for students.
- Having good organization of internal management.
- Having agreements with places in which students can do their professional practices.
- Recognize weaknesses with responsibility and commitment for an improvement plan.
- The way in which we teach some subjects like mathematics, physics, economy, etc.
- Evidence demonstrated at conferences on the progress of own educational model with rate results.
- The strong commitment of ex-students and employers testified the good work that is done by the university in our society.
- The university is attached to national and international academic institutions in order to be engaged to the work related to research in various areas of computer engineering

Academic principles for the development of the plan

We seek a systemic equilibrium based in long term work and the experience of teachers in recognizing and see reality, in order to project a sustainable development of professionals. We seek our professional to have a social impact in our region, concerning issues that are important in our time. Computer Engineering Science program follows the principles of the university, to have coordination, monitoring and harmonization in the curriculum.

Implications

- Improve internal processes in teaching and learning and recognizing that we work with results that lead us to have an identity seal and prestige.
- One of the results the university wants to achieve is the validation of the programs. Validation allows the university to give the students a good education in the diverse areas of their disciplinary training.
- The university is making an effort to improve the process of education, according to the education in Chile. We hope that students from our region can contribute to the development of the country.
- This work is done for the welfare and improvement in the quality of training of students and to improve all issues concerning the university.
- We recognize our weaknesses after the process of self-assessment. This allows us to generate changes that will allow us to improve our internal processes together with graduates, employers, teachers, and students.
- When we recognize our weaknesses we can assure that we are giving the best education, all according to the CNA-Chile (Law 20,129).

4. RESULTS AND DISCUSSION

The graduation profile has been evaluated by students, academics, graduated students, and possible employers. We have applied an assessment process given by the CNA. This evaluation gives us feedback and contributes to decision-making in relation to the monitoring and improvement of the graduation profile.

We made question to 20 employers, 80 graduated students, 155 students, and 18 teachers. We asked to teachers if they agreed or not with the graduation profile. 67% agreed and 33% strongly agreed. We also asked if the feel that they have had participation in the creation of the graduation profile. 17% agreed and 83% strongly agreed. 100% of the academics said that they do have participation in the creation of the graduation profile.

59% of the students agreed and 19% strongly agreed when they were asked if they knew the graduation profile of their program. That means that the 78% of the students knew the graduation profile.

31% of employers said that the graduation profile of the program is appropriate for the requirements of the job market. When the graduated students where asked if the requirements of the program (to get the degree of Engineer) were appropriate, 29% strongly agreed, 50% agreed, 13% disagreed, and 8% strongly disagreed.

4.1 Post-validation Challenges

Among the challenges that the validation brings are:

- Increase and develop strategies to boost research.
- Adjust and strengthen the force between employers and the environment.
- Permanent improvement in the formation process and the teaching and learning strategies to contribute to the country's development.
- Maintain short period each between each measurement cycle (2, 4 and 5 years).
- Maintain a constant method for the improvement of learning guides in order to innovate forms and learning styles.
- Support other programs so they can have their accreditations.

4.2 Learning Community

The development of the learning community is based on the principle of generating and sharing knowledge in order to generate interaction and collaboration networks between teachers and students. The work of teachers, students, collaborators, etc., is developed based on achievements and development of the learning results. We support learning with ICT and with the relationship between teachers and students.

4.2.1 Stage Domain

The executive committee of the faculty designs and plans the activities during the academic year. It is in charge of seek topics that will be important for the validations of competences. Each group is organized according to each subject. Each group has a coordinator.

Every group is led by the director of each faculty. Some of the tasks they develop are the review and proposal of new designs for learning guides, apply new ways of teaching, examine the environment, generate links between companies and university, workshops to show the vision of those companies, review the developments of the competences of the students, generate new ways of evaluation, and collaborative work among internal groups of the university.

Each group generates a network that allows the management of schemes, one is based on personal learning environment (PLE) (Dabbagh & Reo, 2011) and the other is based in personal learning network (PLN) (Werdmuller & Tosh, 2005). This is done by the teachers by using a platform called RSICE (Mellado et al., 2015) (https://rs.inf.uct.cl/) or social net of educational integration and collaboration concerning the subjects they are teaching. They can use ICT, as virtual classrooms, chat rooms, generation of surveys, shared documents, and module assignment of activities. On the other hand, they can also use a platform for community groups to develop the process of teaching and learning, is called Moodle (Ferreira & Cardoso, 2005), there they can have centralized management of the courses and subjects that they teach.

4.2.2 Collaborative Domain Stage

The groups of the community interact with other programs in order to give and receive support for the activities concerning the develop of the students. The idea is to maintain the axes present: humanist and Cristian formation, the competences, ICT, and ongoing education. In that way the community interacts with other communities related to basic sciences, in order to develop learning guides that will allow to validate diverse areas of study.

5. CONCLUSIONS

As teachers recognize our work and tasks in the field to improve the professional training we give to students, that leads us to be part of a whole arduous work of great responsibility in our society. We know that despite the work we say we do, we make mistakes that lead us to thoroughly review and reflect on how to give better education to students. Update our knowledge every day leads us to grow and be part of the future of our students in the job market.

The learning community of computer science has allowed a balance to the process of generating contexts to help exploit validation mechanisms in models of competency-based training programs built on learning outcomes.

The process of developing methodologies to achieve objective assessments that lead to states of achievable learning processes educational activities is a challenge that every day scholars, instructors, assistants face in order to deliver quality education.

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MOOCS – THEORETICAL AND PRACTICAL ASPECTS: COMPARISON OF SELECTED RESEARCH RESULTS: POLAND, RUSSIA, UKRAINE, AND AUSTRALIA

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ABSTRACT

Many higher education students are interested in MOOCs. At the same time, numerous questions are still without answers: formal aspects of participation in MOOCs, the type of motivation on the part of students for participation in MOOCs, quality of MOOCs, students' opinions about type, structure, contents, communication in MOOCs and other aspects. The authors of this article have tried conducting analyses of some aspects of MOOCs in Europe and in Australia as well as presenting and analysing the research results of a survey conducted among students of several countries within the framework of the European Union project IRNet (www.irnet.us.edu.pl).

KEYWORDS

MOOCs, higher education institution, International research network, survey, students

1. INTRODUCTION

The current education system is undergoing a global change because it is expected to fully develop individuals, prepare future professionals for living in an open information space, to form their 21st century skills, to ensure their continuous lifelong learning in informal form. There is a need for interaction between different social, economic and technological developments in the field of education in a global context, which specially develops technologies, tools and means of open education.

Many higher education students are interested in MOOCs. Research conducted by staff at Duke University shows that students choose MOOC for several reasons (Belanger, Thornton, 2013 in: Smyrnova-Trybulska, Morze, Varchenko-Tritsenko 2015):

To support lifelong learning or gain an understanding of the subject matter, with no particular expectations for completion or achievement;

For fun, entertainment, social experience and intellectual stimulation;

Convenience, often in conjunction with barriers to traditional education options;

To experience or explore online education.

Theoretical and methodological aspects of (MOOCs) and analysis of selected examples have been described in the authors' study (Szulc 2014). Selected social and educational aspects of MOOCs were analyzed in (Smyrnova-Trybulska, Morze, Varchenko-Tritsenko 2015). The authors explored a trend in modern education referred to as the Massive Open Online Course (MOOC), analyzed the main types of MOOCs as well as current projects involving MOOC, and examined the ways in which they are used to ensure openness in education.

Analyzing MOOCs as disruptive technologies: strategies for enhancing the learner experience and quality of MOOCs have been described by Conole (2013). A taxonomy of 8 types of MOOC was developed by Donald Clark (2013), who described and characterised all types of MOOCs. In an independent study (Gurba

2015) the history of MOOCs as well as contemporary and future MOOCs were analysed and described. MOOCs and pedagogy, didactics of massive open online courses, mass open on- line training courses as a trend in education progress were examined by researchers from different countries (Kukharenko 2013), (Larry 2012), (Lebedeva 2015). MOOCs and open education: implications for higher education were studied by Yuan, Li, Powell, Stephen (2013). The MOOC model for digital practice was analyzed by (Mcauley, A., et al. (2010). Simultaneously, numerous questions are still without answers: formal aspects of participation in MOOCs, the type of motivation on the part of students for participation in MOOCs, quality of MOOCs, students' opinions about type, structure, contents, communication in MOOCs and other aspects.

The authors of this article have tried conducting analyses of some aspects of MOOCs in Europe and in Australia; they also presented and analysed the research results of a survey conducted among students of several countries within the framework of the European Union project IRNet (www.irnet.us.edu.pl).

2. BACKGROUND

In 2008, a new teaching facility was presented in the education sector especially in the e-learning landscape called MOOC or a massive open online course. MOOCs provide low cost and effective teaching and learning for ordinary people globally and locally. MOOC use technology and distance education applications to provide knowledge and skills to students and learners by sharing and transforming cutting edge, advanced information and data. This type of teaching is pushing educational learning and teaching to new pursuits and chases. According to Kesim and Altınpulluk (2015, p. 15) MOOC courses "taught by elite academics in elite universities draw a lot of interest, and provide a complete distance learning environment through assignments, presentations, videos and other course materials".

A MOOC facility allows students and learners, especially in the field of distance education, to employ vast tools to develop, build, and manage their own learning by using the Internet facility and web technologies. MOOC courses are massive, open access, free, accessible to students globally and locally, to enroll and complete their units fully online and in a synchronous mode. This type of teaching is different from traditional teaching as it has various features and components, such as: dynamic, accessibility while the course is open, assessments, accreditation and collaborative nature (Fini, 2009; Martinez, 2014).

MOOC unit materials should be available in various formats, such as text, video and audio, to students, gradually, to understand, recognize, and capture the unit aims in line to complete the assessments and tests and achieve the accreditation at the end. MOOC assessments should be presented in various methods from self-test quizzes and exams, and should be self-scoring to provide immediate feedback to the students and to minimize the lecturer's workload. Usually, MOOC units should be presented and developed with outstanding content, well delivered presentations, and clear guidelines and instructions inline to make students and learners journey with MOOC efficient, effective and well-organized (Simonson, 2012).

MOOCs are divided into two types, namely: cMOOCs, xMOOCs; these two types were coined by Stephen Downers in 2008. cMOOCs are based on learning theory of Connectivism, as students and learners are using digital platforms such as wikis, blogs, discussion forum to connect and collaborate with learning communities and other learners to create and develop concept knowledge. On the other hand, xMOOCs are based on a traditional classroom structure. This type of MOOC involves pre-recorded video lecture with quizzes, tests, and assessments. xMOOCs are created around an academic rather than a community of students and learners. xMOOCs courses can be found on Coursera, EdX, Udacity, Open2Study, and NovoEd.

Integrating and adopting MOOCs in higher education can bring various challenges and opportunities to students and learners, such as developing and enhancing professional skills in Reading; Writing; Research; Information; Critical Thinking; Decision Making; Technology; Digital oral presentation; Drawing (i.e. concept maps); Teamwork; and Languages; personal skills such as Motivation; Leadership; Negotiation, Communication, Problem solving, Time Management, Reflection, Self-Management, and Self Appraisal (Isaias & Issa, 2014; Issa, 2014). These skills are essential for research and workforce in the future. However, challenges can impact both lecturers and students in terms of ICT skills, time consuming character and accessibility (Hew & Cheung, 2014; Martin, 2012).

2.1 Massive Open Online Courses in Australia

In Australia the MOOC idea has become essential for universities and education sector to be able to present cutting edge information about the latest and most recent topics. MOOC started to attract a great number of students and learners from Australia and globally to undertake this type of teaching instead of traditional teaching as this type is practical, flexible, free and dynamic (Guthrie, Burritt, & Evans, 2013). This platform aims to deliver and supply students and learners with new knowledge by using the latest technologies from social network tools i.e. blogs and wikis, as these technologies aim to develop personal and professional skills and develop more collaboration and communication among students compared with traditional teaching (Issa, 2014). Finally, MOOC teaching becomes available for postgraduate and undergraduate students to advance their learning knowledge and to increase their collaboration and communication with students and learners nationally and internationally. The question we need to ask ourselves is whether MOOC teaching will fully replace traditional and face to face teaching.

2.2 Massive Open Online Courses in Europe

In the Bologna Process, 'virtual learning' has mostly been understood as enabling 'internationalisation at home' (European Commission/EACEA/Eurydice, 2015), allowing non-mobile students to have an international experience through virtual mobility. However, in recent years there has been growing interest in so-called 'massive open online courses' (MOOCs), which has forced European countries and higher education institutions to consider this 'new' internationalisation instrument to enhance their international visibility and competitiveness (European Commission/EACEA/Eurydice, 2015).

2.3 MOOCs are Courses intended to Reach Learners anywhere in the World via the Internet

However, it is difficult to say precisely where the boundary lies between MOOCs and more 'traditional' online courses aimed often at a more specific and local public. As developments in this field are changing rapidly, such boundaries may become irrelevant in the near future. (European Commission 2015)

According to a recent study on e-learning in European higher education institutions, enhancing international visibility is by far the most common motivation for setting up MOOCs, followed by developing innovative learning and teaching methods (Gaebel et al. 2014, p. 55).

Generally, in most countries, the share of higher *education institutions offering MOOCs* is very low and is rarely above *10 %.* A notable exception is Spain where *30 %* of institutions are offering MOOCs. In addition, in Ireland and the United Kingdom (Scotland), they are relatively common. MOOCs are most numerous *in Spain (over 200 courses)* and the *United Kingdom (over 150 courses).*

(1) This was highlighted in the 2013 European Commission's Communication 'Opening up Education: Innovative teaching and learning for all through new Technologies and Open Educational Resources' (Opening up Education).

2.4 Massive Open Online Courses (MOOCs) in Europe

Overall, the use of *internationalisation instruments* such as joint programmes/degrees, campuses abroad and MOOCs varies across the EHEA.

This is clearly a fast-evolving arena and efforts are needed both at national and institutional level to optimise the full potential of these internationalisation instruments (European Commission/EACEA/Eurydice, 2015).

2.5 Massive Open Online Courses (MOOCs) – still a Hot Topic in Europe

MOOCs are still of high and seemingly growing interest at European universities. At the time of the survey, only 31 of the responding institutions *(12% of the sample),* either offered MOOCs or were just about to launch them. But almost *half of the 218 institutions* that did not offer MOOCs indicated their *intention to introduce them.*

This is further confirmed by the fact that one third of all the institutions had a formal position on MOOCs – a positive one for the majority – and a further *42%* intended to develop one. There is no convincing correlation between taking up MOOCs, and a particularly strong engagement in other forms of e-learning. However, *technical universities* were more likely, in the small sample of institutions, to already have MOOCs.

2.6 What are MOOCs?

"*The future is already here, it's just not very evenly distributed*" said William Gibson (Gibson in: Clark 2013); that is certainly true of MOOCs. We have MOOC mania but 'all MOOCs are not created equal' and there's lots of species of MOOC. This is good and we must learn from these experiments to move forward and not get bogged down in old traditionalist v modernist arguments. MOOCs will inform and shape what we do within and without institutions. What is important is to focus on the real needs of real learners (Clark 2013).

2.7 Taxonomy based on Pedagogy

It is important to define taxonomy of MOOCs not from the institutional but the pedagogic perspective, by their learning functionality, not by their origins. Figure 1 shows the eight Taxonomy based on pedagogy (Clark 2013).

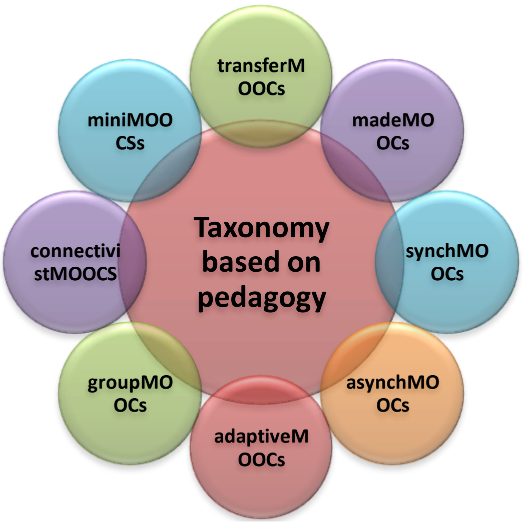

Figure 1. Taxonomy based on pedagogy
Source: (Clark 2013)

2.8 Overview of MOOC Experience in Russia

In Russia, MOOCs are now actively used in learning foreign languages. However, in general, the activity of Russian universities in the development of quality content for MOOCs is relatively low. A number of universities began to develop their own public resources, but they rather may be called experimental, i.e. they are created in order to work out effective technologies of interaction with a large audience of students (Lebedeva, 2015).

In April 2015, eight of the leading Russian universities formed a non-profit organization - the association "The National Platform of Open Education" for the joint development of on-line learning. The Association's task is to create a resource that will host the Russian-language courses that give basic knowledge on the subject matters of basic educational programs (undergraduate and graduate). [Leading universities of Russia non-profit organizations have created for sharing development of online education [Electronic resource] // Mode of access: <URL: минобрнауки.рф/новости/5369].

The Ministry of Education and Science is considering several ways of using MOOCs to enhance the variability of educational programs tailored to the individual needs of students:

- As an additional content for self-study, with no requirements for monitoring results.
- As a mixed model of learning, but it only applies to courses that are available on the project “The National Platform of Open Education”. In this case, a MOOC is part of the curriculum, which is obligatory for the theoretical and practical study, as well as taking into account the results obtained.
- As a prerequisite for developing a university special regulatory framework for formal credit of results obtained in a MOOC study, selected by students themselves.

All of this suggests that the practice of developing and using MOOCs in Russia has a positive dynamics. Teachers need to develop not only the specifics of MOOCs inclusion in the educational process, but also courses as such because they are one of the factors determining the competitiveness of the university. These courses have a high potential or in-service training and retraining of teachers. For example, after the development of a MOOC a learner takes an official final examination and obtains a certificate of professional development. This model currently is seen as temporary, because not all educational institutions have already adopted regulations allowing certifying the results of undertaking a MOOC.

It can be also noted that the development of mass online education in Russia is hampered by a number of factors. These factors are the following: language barriers, lack of MOOC inclusion experience in higher education programs, lack of students’ readiness to work with a high degree of self-organization, lack of employers’ experience in consideration of MOOCs results when hiring employees or offering financial incentives. Nevertheless, in the pedagogical research and practices, the technology of effective MOOC development and use is an up-to-date issue. A number of technologies and ICT tools used in MOOCs are being tested in e-learning practices in Russian universities.

On the Coursera platform, several Russian universities offer a number of MOOCs. These universities are the following: Natural Research Nuclear University, Saint-Petersburg State University, High School of Economics, Peter the Great St. Petersburg Polytechnic University. Analysis of the offered courses content shows that most of the courses originate from the natural science field. For example, such courses as Physics, Bioinformatics, 3D Printing, Programming, etc. are offered. At the same time, there are also such courses as “Social Media Platforms: history, the audience, the possibility of using”, “Psycho diagnostics”, “Russian language for foreigners”. The majority of the courses are offered in Russian, and there are just a few courses available in English.

2.9 Methodology and Some Research Results

A survey has been conducted in several IRNet project partners’ universities: University of Silesia (US), Poland, Borys Grinchenko Kiev University (BGKU), Kiev, Herzen State Pedagogical University of Russia (HSPU), Saint Petersburg, Russia, Curtin University (CU), and Perth, Australia). Below are presented survey results, with participation of 99 respondents (US, PL), 69 respondents (BGKU, UA), 54 respondents (HSPU, RU). The questionnaire was prepared in Google Drive (Google Form), was anonymous and students of different specializations were invited to complete it. The University of Silesia conducted the survey at the Faculty of Ethnology and Sciences of Education among students of the humanistic specialization: Integrated Primary Education and Kindergarten Education, Kindergarten Education with Child’s Development Early Support, Social-Cultural Animation with Cultural tourism, Integrated Primary Education and Pedagogical Therapy; in total 99 students took part in the survey. The results of the students’ responses of to the some question presented on the Table 1 – 6.

Table 1. Results of the students’ responses of to the question: *Are you familiar with the term MOOC (Massive Open Online Course) (Single answer question)*

	US	**BGKU**	**HSPU**
Yes	37,7%	44,9%	81,3%
No	62,6%	55,1%	18,8%

Source: Own research

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Table 2. Results of the students' responses to the question: *Have you attended a MOOC course? (Single answer question)*

	US	BGKU	HSPU
Yes	24,2%	23,2%	37,5
No	75,8%	76,8%	62,5%

Source: Own research

Table 3. Results of students' answers to the question: *Which MOOC platforms are you familiar with? (Multiple choice question)*

	US	BGKU	HSPU
EdX	12,1%	11,6%	25%
Coursera	7,1%	24,6%	59,4%
UDACITY	5,1%	7,2%	15,6%
Udemy	6,1%	15,9%	0%
P2Pu	11,1%	2,9%	0%
Khan Academy	4%	14,5%	15,6%
Prometheus	5,1%	17,4%	0%
I am no familiar with MOOC platforms	70,7%	11,6%	34,4%
Other	0	24,6%	15,6%

Source: Own research

Table 4. Results of students' answers to the question: *Choose a reason for attending a MOOC (Multiple choice question)*

	US	BGKU	HSPU
Interesting new topic	55,6%	47,8%	37,5%
Need for a certificate	15,2%	19,6%	3,1%
Basic course to support a major course	15,2%	15,2%	6,3%
Your own satisfaction	30,3%	-	9,4%
other		17,4%	3,1%

Source: Own research

Table 5. Results of students' answers to the question: *What are your expected results of attending a MOOC? (Multiple choice question)*

	US	BGKU	HSPU
Mastering a new theory	39,4%	40,5%	53,1%
Mastering new practical skills	47,5%	21,6%	46,9%
Mastering new skills, necessary for new competences at the workplace	25,3%	18,9%	78,1%
Educational support	32,3%	18,9%	9,4%

Source: Own research

Table 6. Results of students' answers to the question: *Reasons to drop out of a MOOC (Multiple choice question):*

	US	BGKU	HSPU
Long duration of the course	35,4%	50,7%	56,3%
Unengaging thematic scope of particular parts	24,2%	62,7%	37,5%
Long duration of particular parts	19,2%	22,4%	40,6%
Assessment	12,1%	14,9%	25%
Lack of assessment	18,2%	13,4%	3,1%
Time-consuming tasks	22,2%	49,3%	56,3%
Lack of a logical structure	12,1%	40,3%	34,4%
Lack of feedback	15,2%	38,8%	46,9%
Lack of prescriptive guidance of the tutor	12,1%	22,4%	12,5%
Other______________________	3%	0	9,4%

Source: Own research

One of the survey questions asked about Reasons to unsubscribe from MOOC. Among the most important reasons to unsubscribe from the course, cited by the respondents who participated in the survey, was too long duration of the course. In addition, as emphasized in the study (Gurba 2015), the authors of mass courses recognize more and more the necessity to provide more practical direction and implementation courses in order to keep their participants for longer and prevent them from leaving the course before completion. Not only the design of the course-design approach problem is a solution, but also a good set of partners from outside the academic world, and the industry, services and areas of practical applications. The development of design types of mass courses is one of the important directions of modification on the the MOOC floor. Some authors use a new name MOOP, in which the letter P stands for “project”, instead of “course”. We are therefore faced with a creation massive open online projects, rather than the usual courses MOOC2 (T. Toikkanen, MOOP: The Next Step beyond MOOCs, "Tarmo.fi Blog" http://tarmo.fi/blog/20x5/04/moop-the-next-step-beyond-moocs) In: (Gurba 2015)).

3. CONCLUSIONS

When reviewing statistic data and maps concerning massive open online courses (MOOCs) in Europe and countries in which public higher education institutions offer MOOCs, 2013/14, we note that it is not yet an absolutely balanced and common phenomenon, but we can observe the dynamic growth in the number of courses and their diversity. The factors and conditions for developing new MOOCs in higher institutions are:

– Motivation on the part of students who study and will work in conditions of digital space, global world economy;
– Dynamic development of new competences, new professions, new skill which need to permanently improve the qualification;
– Self-study, lifelong learning, sometimes with no requirements for monitoring results.
– New IT-technology and creative tools for elaborating MOOCs
– resolution and regulation of the formal and legal aspects, which will provide the possibility for participation and successful completion of MOOCs not only as informal but also as a formal educational achievement (ECTS credits) for students.

The authors of the article, researchers of the international consortium IRNet will continue the research. Now the MOOCs “IT-tools for effective use in e-learning” are progressing. The editors, researchers will further analyze the results of the students’ survey and will improve the methodology, content, form of presentation of didactic materials, tools for communication of learners, etc. and will present results in their subsequent publication. We accept the fact that the development trend is still current, popular, quite effective, and it should take into account higher education institutions.

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EVALUATING THE DESIGN AND DEVELOPMENT OF AN ADAPTIVE E-TUTORIAL MODULE: A RASCH-MEASUREMENT APPROACH

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ABSTRACT

Courseware designers aim to innovate information communications technology (ICT) tools to increase learning experiences, spending many hours developing eLearning programmes. This effort gives rise to a dynamic technological pedagogical environment. However, it is difficult to recognise whether these online programmes reflect an instructional design (ID)-model or whether they can be substantiated through sound ID principles. This study presents a systematic courseware design-validation procedure; giving preliminarily empirical results from learners' cognitive performance outcomes. A series of 2x3 factorial quasi-experiments were conducted to validate the performance instrumentation and to substantiate the effectiveness of the proposed courseware-design model. A total of 167-participants, from four higher education institutions took part in this research project. Participants' cognitive preferences were identified using the cognitive style analysis (CSA) test. Initial observations suggest that testing instruments were able to make reliable probabilistic inferences of the cognitive performance outcomes.

KEYWORDS

eLearning, instructional design, Rasch measurement, courseware evaluation, learners' cognitive preferences, cognitive style analysis

1. INTRODUCTION

Since the inception of the instructional design (ID) discipline by Robert Gagné (1985), many research studies since then have investigated how to improve the instructional environments and learning experiences that promote the acquisition of specific knowledge and skills (Merrill et al. 1996). The literature reveals the proliferation of such ID-models among various schools of thought. The most widely applied models include: the generic ADDIE (1975); the Hoffman and Ritchie's ICARE (1998); the Dick and Carey (1978); and Heinich et al's ASSURE (1996). However, further reviews pinpoint the limitations of existing ID-models as being ineffective and mainly developed to guide the practice of specific tasks (Young 2008). It seems possible that these conclusions can be contributed to the lack of empirical evidence and rigorous ratification processes to measure the effectiveness of these ID-models under different instructional environments as claimed by Branch and Kopch (2014). Thus, the main objective of this paper is to describe the ID-design process used to develop an eTutorial courseware module and the calibration of the testing instruments used to examine the expected changes in the knowledge acquisition following the learners' courseware participation. This is an initial paper in a series of papers which are planned to describe a doctoral research study. The structure of the paper commences with an overview of ID-models, then it presents the prescriptive ID-model adopted for this work. Next it briefly describes the design and development of the eTutorial courseware module. The doctoral methodology sections include: the experimental procedures carried out, and the development of the testing instrumentation. The preliminary findings are then presented relating to the validation of the testing instrumentation; the paper closes with a conclusion/discussion.

2. ID-MODELS

Currently, there are scant contributions in the literature from the instructional systems design (ISD) community that is applicable for Web 2.0 instructional-media. For instance; there is: the Dick & Carey 1970's Model (revised by them in 2004); the 4C-ID model (van Merriënboer, Jelsma & Paas (1992), then revised by van Merriënboer & Jochems (2004); and the ASSURE model devised by Heinich et al, (1996). Instead the researchers use familiar ID-models that were designed for use before the advances that multimedia now offers courseware design. We believe therefore, that this paper is focused on the collision point concerning the use of long established ID-models to represent the pedagogical development of the ISD for online courseware with the novel approach that such technological advances deserve. Culatta (2013) has published a list of commonly accepted prescriptive ID-models that use commonly known ID-specifications or theoretical frameworks to advance the creation of instructional programmes. However, through closer scrutiny of this list of 25 such pedagogical models, there are only 14 that focus on ISD that have been updated for our modern computing environment. And so, one of the purposes of this study was to bring forward the evidence for updating the ISD community with our prescriptive ID-model, through our courseware design-evaluation techniques.

2.1 Substantiation of the Prescriptive ID-model

The prescriptive ID-model used in this study involved key ID elements, including: analysis (of the instructional content); design (of the ePedagogical content and assessment strategies); development (of the online IS-artefacts); implementation of the instructional programme and evaluation of the effectiveness of the instructional outcomes) (figure 1). This ID-model extends the Branson et al. (1975) ADDIE model through the systematic examination of the participants' performance outcomes. Our ID-model is based on key activities involving: planning out the required change in the instructional environment; executing the methodology; observing the results; analysing the subsequent data; refining the test-items; recording the results; and reflecting on the subsequent outcomes. We propose that the systematic running of the successive studies together with the continual data analysis of the performance outcomes provides the empirical evidence to substantiate the effectiveness of this ID-model.

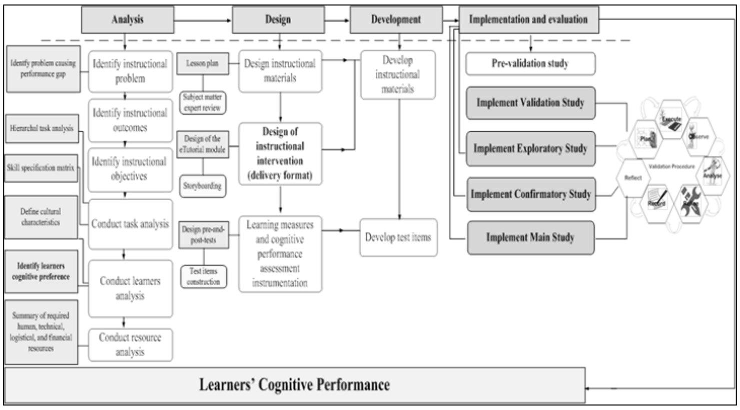

Figure 1. Prescriptive ID- model adapted from ADDIE, Branson et al. (1975)

3. THE DESIGN OF THE E-TUTORIAL MODULE

The learning content and lesson-plan used to develop the ePedagogical materials were exactly the same in the three educational environments (T1 face-to-face (traditional classroom facilitation), T2 blended (combination of traditional classroom facilitator-led and computerised interaction), and T3 wholly computerised (online) interaction). The instructional objectives of the eTutorial courseware module were designed to enable the students (with the help of information communications technology (ICT) tools) to identify data-flow diagrams (DFD) levels, thereby constituting a complete DFD set. Several key information systems (IS)-design activities were undertaken, such as: storyboarding and system testing, were conducted during the design and development of the eTutorial courseware module. Key ID principles were adopted to promote effective learning and to optimise knowledge acquisition. Some influential ID elements were used, such as:

- **Home page:** The eTutorial started with a 'welcoming page' aimed to introduce learners to the topic and how the structure of the overall module (Clark & Mayer, 2008). To conceptualize the abstract notion (Merrill & Tennyson, 1977) of DFD levels, the module was designed depicting a multi-levelled business building with the context diagram as the Ground Level leading to other levels (see Figure 2).
- **Instructions page:** The instructions page (Figure 3) was designed to inform learners of how the eTutorial module worked and the interactivity features they could use when starting the tutorial (Knowlton & Simms, 2010). And so, the eTutorial was divided into four main parts: context diagram; level-0 diagram; level-1 diagram; concluding with quiz activities (providing immediate feedback).
- **Self-paced orientation:** Prompting self-paced eTutorial browsing enabling self-timed instruction.
- **Interactivity features:** The eModule offered a range of interactive elements which were specifically designed to align with different cognitive styles/instructional mode preferences (for verbal/pictorial instructional media) and to promote enhanced learning opportunities. For example, navigation bars were available in two locations on the computer-screen. The one at the bottom of the screen was designed for Analytic users to allow smooth movement among the module parts since they tend to view content as a connected parts focusing on one part or two at a time. Whereas the knowledge-navigator bar on the left-side of the screen may attract the Wholists, who cognitively process their information in an overall manner; thereby providing users with the option to skip, repeat, or choose certain parts of the lesson (figure4).
- **Presentation of materials:** The instructional content was presented in textual blocks, associated pictures, and diagram-mode in order to facilitate acquisition of knowledge for the Imagers who prefer pictorial representation; while the Verbalisers learn faster from text-based materials (Riding & Rayner, 1998 McKay, 2002). Colors were used to highlight critical parts of the lesson. For instance, Wholist participants are more likely unable to make clear distinctions among different ePedagocical-parts due to their (inherent) holistic processing preference (Riding & Cheema, 1991). Similarly, Analytic preferenced learners may overlook integral parts as they focus on one or two ePedagogical-parts as they 'think' about the information they are receiving (Riding, 2001; McKay, 2000). Thus, colors were employed to draw in both cognitive-preferenced groups' attention. In addition, a click button sign was located next to instructional content to provide extra knowledge for the learners who would like to gain more information on a topic or a concept.

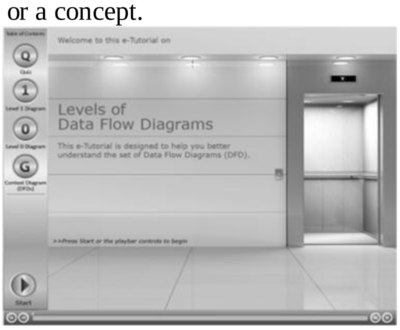

Figure 2. The homepage of the e-tutorial module

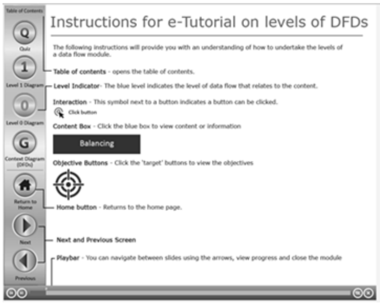

Figure 3. Instructions page of the e-module

Figure 4. Interactivity features

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4. METHODOLOGY

4.1 Participants

A total of 167 undergraduates, who were officially enrolled in the 'Information System Analysis and Design' (ISA&D) course at four public HE institutions, volunteered for this study and took part in different stages of the experiments. Two months prior to the main experiment, participants underwent the cognitive styles analysis (CSA) (Riding & Cheema, 1991), a computerised assessment test used to identify their cognitive preferences. The CSA results (figure 5) were recorded in an Excel spreadsheet, and used to randomly assign participants into one of the three instructional delivery mode groups. Figure 6 is an illustration of participants' allocation process based on their CSA results. The blue triangle represented participants in the conventional instructor led/ F-2-F group, the green diamonds depicted the computerised group, and the red square represented the blended group (classroom instructor and parts of the computerised module).

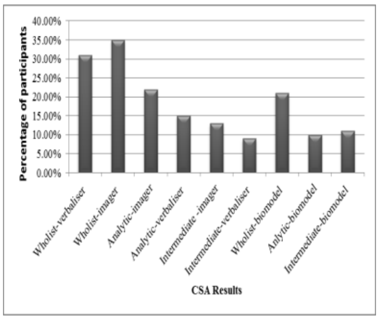

Figure 5. CSA results

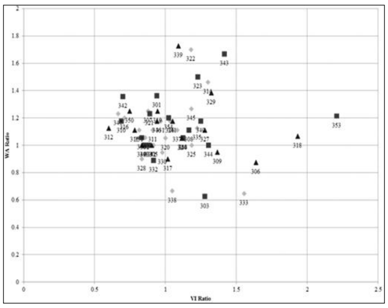

Figure 6. An illustration of participants' allocation

4.2 Experimental Research Procedure

The experimental approach, adopted a series of 2x3 factorial quasi experiments that were conducted for separate sequential studies that were planned for this research project. The staged quasi-experiment (figure 7) was carefully designed to start with a formal registration process during the first step, followed by a short verbal explanation of the research schedule, after which participants underwent a pre-test (the first instrumentation assessment designed to assess their 'entry' knowledge prior to the instructional intervention). Then participants were randomly allocated, by the researcher, into one of the three instructional delivery modes (T1, T2 or T3 mentioned earlier) using their CSA results. Next was the instructional intervention in which each group took the same instructional content in different modes, as T1, T2 or T3. The final step was the post-test (the second instrumentation assessment aimed to measure the participants' change of knowledge after the intervention). All participants underwent the experiments under comparable conditions. For instance, they received the same lecture instructional content without prior knowledge of the topic under different delivery modes T1, T2 or T3) within the same timeframe, and were assessed with the same assessment tools (pre- and post-tests).

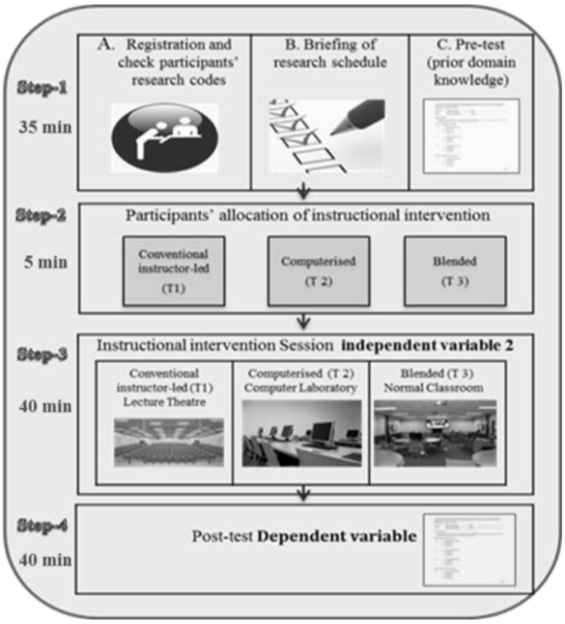

Figure 7. Experimental procedure

4.3 Research Instruments

4.3.1 Instructional Materials

A hierarchal task analysis based on the Gagné (1985) hierarchal task analysis approach, was conducted to narrow down the pedagogical focus. Process Modeling with DFD techniques was the chosen instructional-lesson in an ISA&D undergraduate course. The output from this activity was the identification of entry-level skills and required skills to successfully achieve the instructional objectives. The experimental lesson plan was then prepared based on the Gagné conditions of learning theory (1985) and the Reigeluth (1983) elaboration theory. Next was the design of a 'skills development matrix' which guided the data collection and analysis process, adapted from Mat-Jizat (2012); McKay (2000). The horizontal axis of this matrix was designed based on the type of analysis knowledge (commencing with declarative then procedural attributes) and the six intellectual learning categories identified by Gagné (1985). The vertical axis represented the required ISA&D skills identified necessary for a participant to achieve the instructional objectives that were plotted according to their difficulty level starting at the point of origin on the matrix, with the easier skills to the more difficult ones.

4.3.2 The Pre-and-Post-Tests

The pre-and-post-tests formed the main assessment instrumentation. Thus, it was necessary to follow the Izard's (2005) systematic approach in constructing test-items. This step was critical in order to ensure that the test-items would provide meaningful evidence by which to make reliable inferences. As for the scoring technique, participants' raw scores for each test-item were converted into numeric values to align with the QUEST analysis software. Dichotomous and partial credits were the main scoring categories. Answers from dichotomous test-items were recorded as a '0' or a '1,' whereas partial credit items were recorded with a '0,' '1,' or a '2.' Participants' scores were documented in a data table and saved as a data file.

5. PRELIMINARILY FINDINGS

Results for this paper include the preliminarily analysis of a series of a particular data set, as declaring the full data for this research project is beyond the scope of this paper. Therefore, these data must be interpreted

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with caution. The QUEST interactive test analysis system (Adams & Khoo, 1996), was built based on a Rasch model (Rasch,1993) and the Item Response Theory (IRT), was used to analyse the data. It generated results such as: fit statistics; and test-item and case (participant) estimates, in the form of maps and statistical-tables. Some of the empirical data below is at its first iteration, which with subsequent analysis runs will provide a deeper analysis for this study's variables.

5.1 Validity of Assessment Instrumentations

It was necessary to first calibrate testing instrumentation as implications/conclusions depend on the assessment instruments' assured validity and reliability. During our prescriptive ID-model's design phase, there were four separate studies that were conducted to align with its aim as the formal calibration of the testing instrumentation. Results from these first two studies were used to monitor the behaviour of test-items, and to delete or substitute unsuitable test-items for subsequent studies. Thus, many adjustments were made prior to data collection for the main study. The QUEST item fit map (table 1) provides a visual representation of the magnitude of the fit statistic of test-items that were conforming to the Rasch requirements. Table 2 represents the item fit maps of pre-and-post-tests from one study conducted for this research project. Each test-item is represented by a star and should lie within the dotted lines (thresholds), which define the acceptable range of good behaving test-items. Unreliable test items lie outside the dotted lines. For example, test-items 12 and 22 on table 1.a, cannot be considered conforming to the Rasch model because it is not behaving in a consistent manner to other test-items. Table 1.b shows all test-items lie between the dotted line, fitting the Rasch model, and therefore deemed reliable.

Table 1.a. Item Fit map (Pre-Test)

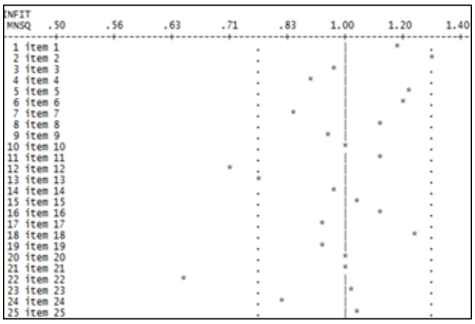
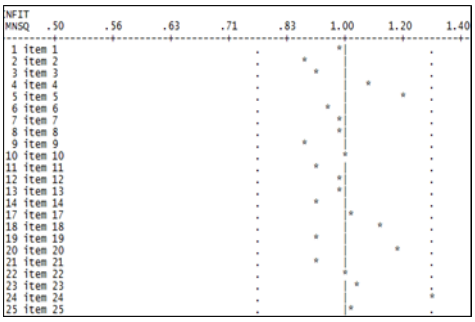


Table 1.b. Item Fit map (Post-Test)



5.2 Participants and Test-items' Performance Indices

The QUEST variable map provides measurement indices of participants' performance relative to other participants, and relative to test-items. It enables the performance evaluation of participants and test-items simultaneously on a uni-dimensional logit scale. The variable maps of post-tests from the four studies conducted for this research project are shown in figure 8. The left-side of each map shows the distribution of participants' abilities based on their performance (each X represents a participant). And so, the performance of participants on the upper left of the maps is better than participants at the lower left of the map. Test-items are plotted on the right-side of the map, based on their difficulty level in an easiest-bottom to hardest-top sequence. Thus, test-items positioned on the lower right deemed too easy to challenge participants' abilities whereas items on the upper right were beyond participants' abilities-level.

Looking at these maps, and as mentioned previously that Study 1 and 2 aimed to test the reliability of test-items on a small population (15, and 52 participants respectively) prior to conducting further studies. These initial observations required improvements which included the addition of test-items targeting the measurement of higher skills on the skills matrix (table #). We tested to the reliability of the 'new/added' test-items by give the test for a larger population as to improve the precision of test-item measures. And so, the subsequent studies had larger well-targeted population (91 participants), which provided better information. Variable maps for Study 3 and 4, shows better test-items/people's performance distribution. Calibration carried out on the sample for previous studies, validated the construct scaling as to facilitate the acquisition of skills of 'Data Modeling with DFDs,' from the easiest into the hardest sequence. Data for study

4 was a combination of dichotomous and partial credit scored test-items, and participants were mostly clustered between 0 and 3 logits (very few were located outside that). Any participant with ability below 0 logit and beyond 3 logit was excluded from analysis, because there were not enough test-items to match their estimated achievement level. Test-items that did not test any participant's ability were also discarded, as there were not enough participants to measure its reliability. Although, data from these sequential studies, at its first iteration, test instruments provided sufficient adherence to the Rasch measurement requirements. Therefore, it can be considered reliable to conduct a deeper analysis to measure the cognitive performance. Further analysis for this research project is planned to model data from other QUEST estimate outputs in order to investigate and compare the performance of different groups involved based on their cognitive preference (Wholist-Analytic and Verbaliser-Imagery), or delivery mode (F-2-F, blended, and computerised).

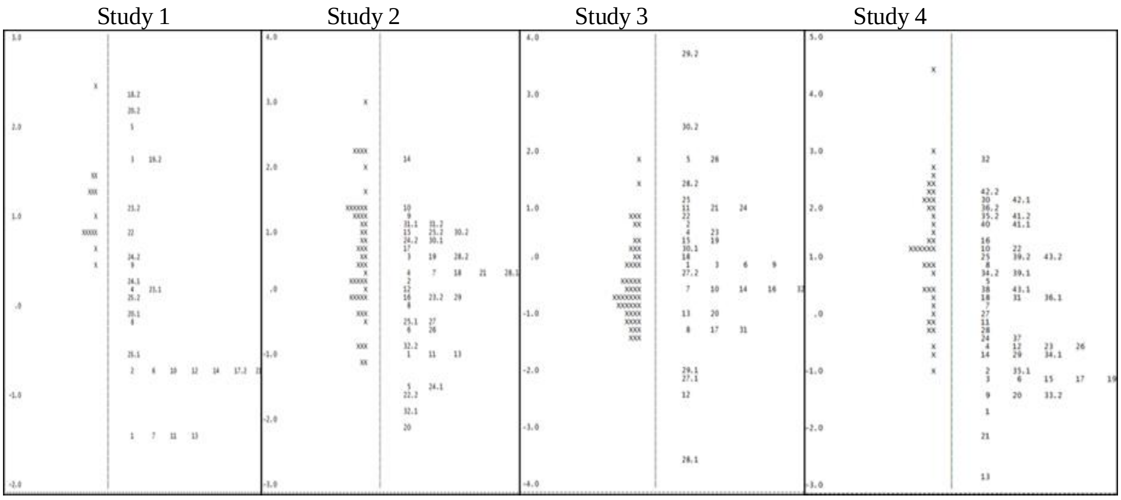


Figure 8. Variable maps of post-tests from four sequential studies

6. CONCLUSION

Instructional systems (courseware) designers are using traditional ID-models for their development of the online instructional programmes. Consequently with the advent of the more powerful Web 2.0 multimedia tools, knowing which the best ID-framework to use can be a vexing issue, especially when considering instructional systems design. There are ID-models that people use, however it has been suggested in this paper that few of these are suited for adoption in 2016 and onwards. Consequently, the need for development of new prescriptive ISD-models is apparent. To this end the prescriptive ID-model used in the research described in this paper reflects the call from the literature for such IS-design innovation.

We set out to explore the effectiveness of adopting the ADDIE model, thereby bringing it forward as an ID-model exemplar for ISD practices, in the first instance and as necessary evidence supported by a comprehensive data analysis of the participants' performance outcomes. To this end we operationalised the research variables (instructional treatments represented by face-to-face as the traditional classroom facilitation, a blend of the traditional facilitator-led and computerised instructional activities; and the wholly computerized online approach, in an empirically design set of experiments. The primary aim of our research was to investigate the interactivity of the instructional treatments and the participants' cognitive information processing characteristics, using the cognitive style analysis (CSA) test that we used to allocate participants randomly to their instructional treatment groups. We have reported on the initial data analysis in this paper as a forerunner to the outcomes from the main experiment. Already we are able to show there were changes in knowledge outcomes on data flow diagramming techniques.

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ANALYSING STUDENTS' INTERACTIONS THROUGH SOCIAL PRESENCE AND SOCIAL NETWORK METRICS

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Federal University of the State of Rio de Janeiro - UNIRIO

ABSTRACT

In online learning environments, tutors have several problems to carry out their activities, such as evaluating the student, knowing the right way to guide each student, promoting discussions, and knowing the right time to interact or let students build knowledge alone. We consider scenarios in which teaching and learning occurs in online social networks platforms and in order to support tutors' knowledge on the students' interactions, we propose an approach based on social presence and social network analysis. The solution consists on mapping profiles through the observation of interactions occurring in an online social network, then using automatic textual analyses of social presence based on the criteria of affection, interaction, cohesion and strength, as well as metrics for social network analysis to see the interactions and connections of members in the social network. We applied the approach in a case study and the students agreed their profile represented them correctly and the proposed solution had good acceptance.

KEYWORDS

Social Presence, Social Networks, Social Network Analysis, Learning Technologies, Technology Enhanced Learning

1. INTRODUCTION

The amount of users and the Internet usage rate has been increasing at an accelerated rate. Technologies are useful in different environments, whether in classrooms or outdoors, creating new spaces for communication and interaction on social networks. The social media is leading to the next generation of social learning innovation [Lytras et al., 2014].

Language is a social practice that organizes and structures the human relations [Vygotski, 2012]. Support and contact among students and teachers can be problematic in the distance learning, as the contacts happen mediated by machines. It is necessary to establish a network of relationships built between the participants and between them and the learning contents, in a scenario where the feelings and emotions should also be perceived [Bastos et al., 2013]. Therefore, an important activity for teachers and tutors is to observe and to support the participation of students in discursive interactions in order to maintain the sharing spirit of mutual trust and support among participants of a course [Marques et al., 2013] [Krejci and Siqueira, 2013].

The activity of observing and supporting students interactions is related to the notion of social presence (SP), which is an aspect considered relevant for establishing interpersonal relationships, particularly in text-based interaction resources [Garrison and Archer, 2000] [Mackey and Freyberg, 2010]. The SP is the degree to which a person is able to get herself attached to the course or study group, communicate effectively in an environment of trust and develop personal and affective relationships, designing her individual personality in computer mediated communication [Garrison, 2011].

In online discussions there are lots of messages shared between students and tutors, which express doubts, opinions and feelings. However, it is difficult to track the volume of online messages and understand the behaviour of students, making the role of tutors harder in supporting the development of students' knowledge. When analysing the interactions between the participants, one may also understand the underlying social network of the participants, which could also provide important information about the discussions. Therefore, we propose the extraction of social presence and an analysis of the interactions performed on an online social network platform. A prototype was developed to support a case study with students and tutors who used an online social network platform for performing communication activities in a course.

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The remainder of this paper is organized as follows: the 2nd section presents a brief overview of the e Community of Inquiry (CoI) and the Social Presence (SP) concepts. Section 3 describes the face-Presence architecture proposed in this work, the 4th section shows how the case study was conducted, the 5th discusses the analysis of the results. Finally, the 6th and last section presents some final remarks.

2. COMMUNITY OF INQUIRY – COI, AND SOCIAL PRESENCE – SP

The Community of Inquiry (CoI) model was created in order to guide the use of asynchronous communication in written form, mediated by computer to support the development of critical thinking in higher education [Rourke et al., 2001] and prioritized into a space for discussion of academic subjects. The online collaborative constructivist experience is represented as an intersection of a function of three elements that interact dynamically: social presence, cognitive presence and teaching presence [Akyol et al., 2009].

The first element in the model is the development of cognitive presence, which is defined as "the extent that participants in any particular configuration of a research community are able to construct meaning through sustained communication" [Garrison and Archer, 2000]. The second element is the teaching presence, which includes designing and managing learning sequences, providing subject matter expertise, and facilitating active learning. The third element is the social presence (SP), defined as the ability of students to make themselves socially and emotionally noticeable in a community of inquiry. The social presence supports the cognitive goals through its ability to instigate and support critical thinking in a community of learners [Rourke et al., 2001]. It also supports the affective objectives, making attractive the interactions, engaging group, and therefore intrinsically rewarding, leading to increased academic, social and institutional integration and resulting in increased persistence and graduation [Tinto, 1987].

These three elements have a key role in the construction of meaningful learning by learners [Swan, 2010]. It is extremely important that students feel part of the group and there is empathy with the teacher and classmates for learning effectiveness. The cognitive presence, social presence and teaching presence must work together to reach the educational experience.

SP is the degree to which the other person is perceived as a "real person" in mediated communication technology [Lowenthal, 2000]. This concept is considered one of the most popular to describe and understand how people interact in virtual learning environments [Gunawardena and Zittle, 1997]. The level of awareness of each other in the virtual learning environment can be influenced both by personal characteristics of each (interest, dedication, initiative, etc.), as well as the resources offered by the environment to convey social and emotional information about the other [Tu, 2000].

[Bastos et al., 2013] set SP indicators (called clues, which were used to detect concepts belonging to SP. Then, the messages written on forums and chats bring important indications for the SP study in virtual learning environments, providing a measure for understanding the involvement of individuals.

The SP supports the emotional and cognitive learning objectives and contains three broad categories of communication responses: (i) affective, (ii) interactive and (iii) cohesive [Rourke et al., 2001]. These three categories are updated in the discourse of participants through observable indicators.

3. FACE-PRESENCE

The proposed approach maps students' profiles from teaching-learning activities in online social networking systems, by analysing their interactions. It also includes other properties related to the interactions that are common in social networks systems, as the amount of likes, shares, tags in the messages and comments. These properties provide more information about the behaviour of individuals in the group, and indicate their social presence as well as the network characteristics.

The first stage of mapping the profiles is the extraction of posts and comments. The second stage of our proposal is social network analysis (SNA), trying to verify the network characteristics according to its structure, making possible to observe the most influential members, the ones who interact more, those with more connections, among other features that may facilitate the planning of the tutors' actions.

For processing each message posted by users, along with the social networks properties, we built an architecture (Figure 1). We tried to reuse existing systems and adapt them, rather than building other ones.

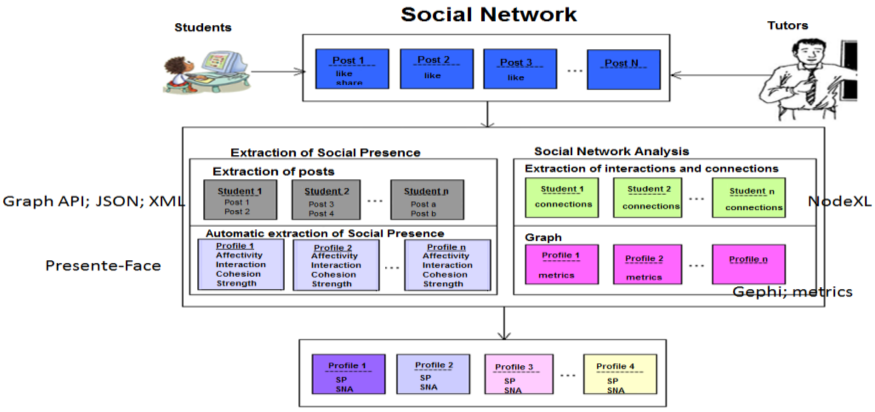

Figure 1. Proposed Architecture

The solution is organized in three main modules: extraction of social presence (in which the group's posts are extracted of the social network and the Social Presence's indicators, subclasses and classes are identified), social network analysis (involving the extraction of interactions and group connections and the analysis of the interactions and connections with a social network analysis tool) and the creation of profiles.

For extraction of the posts from the social network we used the Facebook API that captures, through FQL queries (Facebook Query Language), the data entered by the group members. For the identification of Social Presence indicators we developed the Presente-Face, which consists of an adaptation of the Presente system [Bastos et al., 2013] to analyse the textual data and Facebook properties as like and share. For the other properties it was possible to use the tools that the system already had.

This tool analyses the file of postings based on the categories defined by the teacher or tutor. It takes as input a file with the names of the group members whose analyses are to be done. Then the Analyser returns three types of files: a set of files with the Social Presence detailed for each student; a file with the Social Presence related to the course; and a file with all students and their Social Presence values.

For extracting data from the social network group, in this case the Facebook, we used NodeXL, which is a pre-edited Microsoft Excel template specialized in creating graphs from social network data. The software makes the extraction of all public data made available by the group members as well as the interactions that occurred in the group. For more detailed analysis of graphs we used Gephi, a tool that allows the user to interact with the representation, manipulate the structures, shapes and colours to reveal hidden properties of each chosen graphic, helping to discover patterns, isolate singularities or failures during data supply.

4. CASE STUDY

During the period between February 19th, 2014 and May 19th, 2014, we performed a case study with 10 students and three tutors of the Computers and Education course, of the Bachelor of Information Systems program, at the Federal University of the State of Rio de Janeiro (UNIRIO). Throughout this period of time, students exchanged information through the group created on Facebook for supporting the course activities. The exchange of messages occurred in a natural and spontaneous way, which is an important factor so that it does not influence students to participate.

At the end of the course, the conversations were extracted from Facebook to generate a profile for each student, including the diagnosis of the Social Presence in the group, divided into 4 categories: Affection, Interactivity, Cohesion and Strength. All actions performed by students and tutors within the Facebook group were monitored and extracted. The group interactions were recorded through NodeXL software. As data collection process for qualitative analysis, individual interviews were scheduled with students after analyses of the profiles generated by research. The online interview method was the Underlying Discourse Explanation Method - MEDS [Barbosa et al., 2002]. Interviews were conducted through the Facebook chat with the students and tutors. The tutors were interviewed to analyse the profiles and verify if the obtained information assist them in tutoring activities.

In addition to the qualitative analysis of the interview data, the comments posted by the students during the activities of the subject were quantitatively analysed by checking the Social Presence clues. Together, all participants generated 205 messages, many of them with likes, reviews and tagging of group members. All participants in the case study have good knowledge of using technology in day-to-day and frequently use the Internet through smartphones, tablets, notebooks, etc. Most of the participants already use Facebook to communicate in day-to-day with friends and family. Students and tutors participants of this research are between 18-38 years old, and there were 6 men and 7 women.

The social presence degree (GRPs) is obtained by dividing the number of SP occurrences by the number of posts. Table 1 expresses the results of calculating the degree of Social Presence.

Table 1. Social Presence Degree

Name	Social Presence	Posts	GRPs
Student 1	**189**	47	4.02
Student 3	**122**	23	5.30
Student 2	**89**	18	4.94
Student 5	**53**	12	4.42
Student 4	**39**	16	2.45
Student 8	**35**	12	2.92
Student 7	**25**	7	3.57
Student 9	**10**	4	2.50
Student 6	**9**	4	2.25
Student 10	**2**	1	2.00

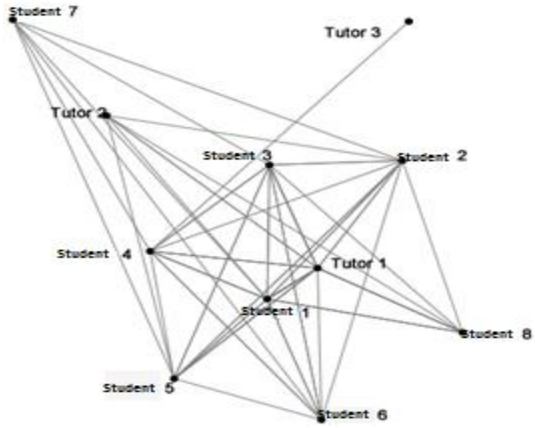

Figure 2. Group interactions graph

Thus, although the amount of messages may be important in the discussion, there is not direct correlation with the SP or GRP. Some Students post messages more focused on content and therefore containing less SP features. On the other hand, there are few students who post messages with interaction and emotion features and therefore more SP (or GRP). Although the Student 1 has a greater number of posted messages and has a larger value SP, the social Presence degree is not the highest, messages did not have many SP characteristics. Moreover, Student 5 posted about 26% of the number of messages that Student 1, about 30% of the total SP value of Student 1, but with a SP degree greater than Student 1. Thus, we noticed that the Student 1 had a higher volume of interaction, but did not promote more involvement of the group than the Student 5.

In addition, only 4 Students had moderate degree of Social Presence, which clearly reflects their participation in online interactions. This is partially justified because it was a face-to-face course and online interactions aimed to complement activities, besides the fact that the students have jobs and often have little study effort out of class hours. Figure 2 shows the graph of group interactions. The nodes or vertices represent the students and tutors and the edges represent the interactions between them. Social network analysis metrics allow a better understanding of the students (and tutors) activities and therefore of the course. Two students were not in the graph as they had no interactions.

The most connected students are Student 1 and Student 2, each one with 9 connections. An actor who has several relationships with other actors can, for example, quickly spread information. The degree centrality measures the degree of each node depending on its relationships and expresses the number of connections (or different people with whom the node is connected) in the network. In Table 2, the students are ranked in descending order according to the degree centrality value.

The students with greater proximity between the vertices are also the most connected (Student 1 and Student 2). And the student with lower proximity was one of the least connected - Student 8 with 0.063. Another actor with few relationships, but that is part of the shortest path between other actors, can exert a certain intervention in the communication between these actors. Through the closeness centrality metric is possible to analyse the students with greater proximity between the vertices with the most connected ones. Table 2 also shows the closeness centrality values displayed in descending order.

Table 2. Degree Centrality, Closeness Centrality, Betweenness Degree

Name	Degree centrality	Closeness centrality	Betweenness centrality
Student 1	**9**	0.091	2.733
Student 2	**9**	0.091	2.733
Student 3	**8**	0.083	1.450
Student 4	**8**	0.083	9.167
Student 5	**8**	0.083	1.450
Student 6	**7**	0.077	0.167
Student 7	**6**	0.071	0.000
Student 8	**5**	0.063	0.200

Table 3. Clustering Coefficient

Name	Clustering
Student 7	1.000
Student 6	0.952
Tutor 2	0.900
Student 8	0.900
Student 3	0.821
Student 5	0.821
Tutor 1	0.786
Student 1	0.750
Student 2	0.750
Student 4	0.714
Tutor 3	0.000

The student with highest betweenness degree was the Student 4, which had 8 connections on the network and betweenness degree 9,167 (i.e. he is not the student with more connections), while the students with more connections in the network has betweenness degree 2,733. It indicates that although the Student 4 has fewer connections, he has greater importance in mediating talks. There was a greater distribution of values, e.g., a student with 7 connections has betweenness degree (0.167), while other student with 5 connections has a higher betweenness degree (0.200), indicating that although he has a smaller number of connections exerts greater importance in mediating talks than the other.

A student with 6 connections present betweenness degree 0.000, while two students with 5 connections have betweenness degree 0.200, indicating that being connected with more people do not influence in facilitating conversation. Table 2 also shows the betweenness degree values.

Considering this group, the values of degree centrality follow the same order of the Eigenvector centrality values, indicating that the importance of a vertex according to its neighbours is bigger for the most connected ones. In Table 3, it is possible to see that the most connected people do not have higher clustering coefficient, which shows that these people have less tendency to cluster than the Student 7 which has degree centrality 6. Table 3 shows the clustering coefficient values displayed in descending order.

5. RESULTS AND DISCUSSION

We conducted qualitative analyses with data collected through interviews. The tutors know the students and interacted online during the period in order to be able to assess whether the received profiles effectively identify the students. The average of the rates for the tutors' confidence on the participants' profile provided by the proposed approach was 9.3, indicating that the tutors have a confidence level of 93% on the profiles.

Students analysed their participation in the Facebook group and the average of the rates obtained to the degree of correctness of their profile was 9.3, indicating that students attributed 93% degree of confidence to their profiles. Qualitative analysis was performed on data collected from interviews in online interviews.

5.1 Challenges to interact on Facebook

When asked about the challenges to interact on Facebook, many students cited the timidity and the difficulty of monitoring the conversations. Some answers illustrate this analysis:

"*I am a person who likes to talk a lot, but do not feel comfortable online. In person I'm not afraid of making mistakes, speaking wrong Portuguese and sometimes even knowing the right, but on the Internet I'm more cautions and it makes the process more bureaucratic.*"

"*My biggest challenge was to interact, especially when beginning a chat on some topic.*"

90% of students agreed that the profile helped to identify their characteristics in the group:

"*I fully agree with the description of this profile. Student with greater betweenness is not the one with most connections. For a person from the humanities, this metric is FASCINATING... !!!*"

"*Yes, with more information about the student one can know who has difficulties in this area and thus it helps you to continue at the same pace that others are.*"

5.2 Challenges to interact Online with Students

When asked about the challenges to interact on Facebook, many students cited the timidity and the difficulty of monitoring the conversations. When asked about the challenges to interact online with students, tutors highlighted the difficulty of following the conversation, stimulating discussion and knowing the right tone for each student. The statements listed below underlie these conclusions:

"*Time to monitor and guide the discussions; know the right tone to guide each student and promote discussions; know the right time to interact or let the students build their own knowledge.*"

"*It was difficult to determine exactly what to say in posts, ask questions for promoting students to speak according to their minds, so I tried respond to posts and not initiate discussions.*"

5.3 Facebook Information supporting the Identification of Students' Difficulties

Tutors were asked about the information that could support the identification of students' difficulties in learning the content. They emphasized the lack of interaction might be indicative of difficulty, commented that questions also help them to understand the difficulties of the students and said that if the student does not interact is more difficult to identify his difficulties. The informality of a social network was mentioned as making it easier for students to express themselves more freely.

"*The questions and the lack of interactions are always a target; interactions on facebook can be simply like (or share), while discussions are important for knowledge construction; the questions are always indicative of doubts; the lack of interaction may be indicative of lack of interest, time problems or even misunderstanding something.*"

5.4 Relevant Information obtained from the Profile

When asked about the information on the profile they considered useful, tutors found that all the information was relevant and pertinent. The social network analysis was also cited as an important factor, which is a great advantage of this research, since only through the Social Presence is not possible to analyse the interactions of the members in the social network, making it impossible to analyse their connections and factors that can influence the participation of the student, such as friendship.

5.5 Profile as a Tool in Mentoring Activities

Tutors were asked if they thought the profile provided useful information of student participation in a social network group. All the tutors said the profile served as a supporting tool in mentoring activities.

"*Yes, with the profile I managed to get the activities on a more targeted manner, directly interact with the elements that can lead the group to develop and to learn better.*"

"*Yes. knowing the students' profile, according to the interactions, one can notice their participation.*"

5.6 Analysis of the Goals Set

All tutors agree that the profiles are useful and can be used to support activities in the course. 9 of 10 students said that the profile helped in identifying their characteristics in the course. The one who did not agreed with his profile didn't read the presentation that explained how the survey was conducted, a key factor to understanding how the profile was built:

"*I think that it does not identify me, because not all social indicators are directly proportional to the activity parameters in the social network, but I did not read the background of this work ...*"

In addition some students said that profile also helped in their self-analysis. If only the SP was examined in this work, some important issues would not be included in the profile, such as an actor having various relationships with other actors may, for example, spread information quickly.

The student with greater betweenness in the groups is not the most connected one, as the student 4 having 8 connections in the network, SP = 2.43 and 9.167 of betweenness degree, while the Students 1 and 2 have more connections in the network got betweenness degree equals to 2.733 and Student 1 has SP degree = 4.02 and the Student 2 has SP degree = 4.94. It indicates that although the Student 4 has fewer connections and low SP degree, he has a greater importance in mediating talks. This analysis brought a reflection for the evaluation of the work, as the Student 4 presents textual clues of vulnerability and said: "I am shy and I do not feel comfortable exposing ideas or thoughts here, especially in writing." SP analysis combined with SNA allowed the perception of the student importance in a group despite having low SP degree.

The Student 6 has 7 connections, betweenness degree of 0.167 and low SP degree = 2.25, while the Student 8 has 5 connections and has a slightly higher betweenness degree 0.200 and low SP degree = 2.91, indicating that although the student 8 has a smaller number of connections, he has a greater importance in mediating the other conversations, and provides more SP.

The Student 7 has 6 connections, shows the betweenness degree of 0.000 and low SP degree = 3.57, while the Student 8 has 5 connections, shows the betweenness degree of 0.200 and low SP degree = 2.91, indicating that although Student 7 is connected with more people and has a higher SP degree, he has no influence in facilitating conversation.

These characteristics support the analyses of the profiles. The SP alone would quantify the occurrence of textual clues of affection, interaction, cohesion and strength, but without the SNA it is impossible to understand the importance of the student in the network, understanding the connections and interactions. Therefore, analysing the objectives and the data obtained from interviews, the result of this work has the potential to be useful, since 90% of students mentioned that the profile represented them properly and all tutors said they helped in their mentoring activities. It was also demonstrated the importance of using both the SP and the SNA to compose profiles, as they together provide information so that tutors can analyse the behaviour of students in the social network and make inferences considering the profiles received as a source.

6. CONCLUSION

The support of the tutor throughout the course is very important to the success of each student. With the proposed approach it is possible to obtain data and issues for improving the teaching-learning process, the identification of individual and collective problems and greater flexibility in problem solving.

The previous proposals dealing with social presence, define the underlying concepts and present a questionnaire for getting information about it [Garrison and Archer, 2000], discuss the influence of social presence [Mackey and Freyberg, 2010] [Rourke et al., 2001] or propose indicators and tools for acquiring social presence from forums and chats [Bastos et al., 2013].

We proposed building students profiles that can be used by the teacher / tutor. Although there other works that capture users (or learners) profiles from their interactions in social networks (e.g., [Fernandes and Siqueira, 2013]), our proposal considers two main aspects: the SP and SNA metrics. With this diagnosis, the teacher/tutor is able to monitor and evaluate the students' interactions, to better understand the students and then make necessary interventions. One can use this information to aid the students' learning process.

This paper presents an approach for capturing the students' profile according to their participation in the courses. The profile is based on SP concepts and SNA metrics, motivated by the large number of data available in the learning environments. Therefore, tutors may use the profiles as a resource to assist in planning their mentoring activities to facilitate the student learning process. In their turn, the students may use this information to self-analysis (or self-assess) their participation in the group. Another contribution of this work is that in a given sample of students and tutors in a particular scenario, in which the students' profiles based on SP and SNA were presented, there was a 93% reliability rate and it showed the potential to help in tutoring. As a technical contribution it is possible to mention the construction of the prototype. In addition, the proposed architecture can be generalized and applied to other social networks.

As future work the profiles could be used in accordance to tutoring strategies to suggest actions to the tutor. It could be also interesting to develop a dashboard with the interactions and allow configuration of analysis metrics and tutoring strategies according to the approach or interest of teachers / tutors or students. In addition, it might be interesting to analyse the social network, partitioning its members in order to find groups that have common interests or characteristics, as proposed in [Guedes et al., 2014], and using educational data mining techniques as in [Gottardo et al., 2014]. Finally, the students' profiles could consider other pieces of information such as the learning styles.

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DIFFERENCES BETWEEN PERCEIVED USEFULNESS OF SOCIAL MEDIA AND INSTITUTIONAL CHANNELS BY UNDERGRADUATE STUDENTS

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ABSTRACT

Social media technologies were introduced among the modern society and are part of its routine in many ways – knowledge acquisition and sharing, interpersonal relationships, media diffusion – sometimes complementing and even substituting tools that were specifically designed for similar activities. This research compares social media sites and institutional communication channels by confronting elements that construe perceived usefulness and system satisfaction. It has been shown that students see more usefulness in social media technologies when performing academic activities than in information systems provided by their university, mainly due to the ease of use of the former technology. Thus it is expected to contribute to students and education institutions in order to attain the better use of available IT tools.

KEYWORDS

Social media, Higher Education technologies, Technology perceived usefulness

1. INTRODUCTION

Social media technologies are currently an important tool for power decentralization. Actions that are typically organized and controlled by small groups (such as governmental agencies, labour unions, student unions and other institutions) start to be disseminated to everyone that is involved. It enables new roles to emerge naturally, without regulated or legal processes (Mackenzie 2013). Thus, social media allows information to be generated, shared and to be potentially accessible for anyone.

Academic communities from education institutes are susceptible to the changes provoked by social media as well as companies, due to their effect on decreasing power restrictions, time and distance. Virtual communities – Facebook and WhatsApp groups, YouTube channels – emerge with or without institutional leaders' acknowledgement or consent. In such groups, students share information about the institution, academic materials (Pimmer, Linxen, Gröhbiel 2012) and opinion about teachers' performance and student services (Otto, Sanford, Ross 2008). Moreover, the use of such nonregulated virtual spaces may affect the grades of students that perform this use (Bennet et al. 2008).

As the use of social media by students is not usually controlled or even known, and that this use can potentially replace formal electronic tools – e.g. Virtual Learning Environments such as Moodle or Blackboard – the institution is prone to waste resources or not reap the benefits from freely available information. When considering that a Higher Education Institution invests human and financial resources in the implementation and maintenance of structures for supporting its activities (teaching materials, proper spaces for students' assignments, systems for faculty's evaluation and institutional e-mail boxing), the organization's strategy for undergraduate students' interactions in virtual environments may not have considered some of the necessities of these students.

Thus, this study investigates factors that could have made students prefer a social media tool when performing educational activities over formal channels that have been made available by the university. The goal is to identify factors associated with satisfaction and perceived usefulness of social media technologies and of formal channels from their educational institution. Then we compare the students' preference between both options for conducting their academic activities.

2. SOCIAL MEDIA

The evolution of applications and Internet's possibilities resulted in the rising and in the improvements of technologies that are more interactive and accessible. Such evolution was once defined in 1999 and later promoted by Tim O'Reilly as Web 2.0 at O'Reilly Media's conference in 2004 (O'Reilly 2005). This wide term essentially comprehends the technologies that allow anybody to create and share content dynamically as well as discuss it with all the users (O'Reilly 2005; Tuten, Marks 2012).

This phenomenon was characterized by the rising of social media. This technology represents a paradigm shift in relation to the predominant way of Internet use at its beginning. When it started to be widely used, the world's computers network was smaller and just a reduced amount of people, who had high technical knowledge, were able and available to spread content. Then, most of common people were just "receptors" of this content (Armstrong, Franklin 2008; Hargadon 2010). Finally, social media technologies enable a massive sharing and self-content building of most of their users.

2.1 Social Media in Education

The variety of social media tools and the growth of its popularity open several possibilities in new forms of use of this technology. The opportunities for collaboration and participative generation of content may improve results, as educational activities (Wankel 2009). Academic research has studied social media in the educational context. These studies comprehend from formal educational systems, which brings the interactions between professor and students, to models with free collaborative learning environments supported by social media platforms. Dabbagh and Kitsantas (2012) reviewed theoretical studies about the potential of social media tools in education and effective applications of them. Bennet et al. (2012), McCorkle and McCorkle (2012), Pimmer, Linxen and Gröhbiel (2012), Tyagi (2012) studied cases of social media sites and tools that are focused in learning processes.

In general, these studies investigate actions that were or could be done for social media use as a learning resource, difficulties and possible results after implementation. After proposing a three-level framework, Dabbagh and Kitsantas (2012) suggest actions for educators to help them use social media as self-regulated teaching support. In an increasing complexity, the levels are "Personal information management", "Social interaction and collaboration", and "Information aggregation and management". They have to be implemented one after another by pedagogical instructors. The intention is to encourage students to build an individual and collective learning environment through social media. This framework is an adaptation from the study of Zimmerman (2000). This author approaches stimulus to individual study regulation, emphasizing the students' role as the main educational agent in social media (Dabbagh, Kitsantas 2012).

3. INFORMATION SYSTEM ADOPTION

Fishbein and Ajzen (1975) have identified *intention* as a reliable predictor that leads to a certain behaviour, and have shown this relation in the Theory of Reasoned Action (TRA). Such intention is influenced by an individual's attitude to a given behaviour and his/her subjective norms concerning how other people would perceive that action. Davis, Bagozzi and Warshaw (1989) have used TRA as a basis for their Technology Acceptance Model. The authors propose perceived usefulness and perceived ease of use as preceding variables for the intention to use a given technology. Despite being a very robust model, some variables may escape its reach (Davis, Venkatesh, 1996) as social and cultural aspects (Bagozzi, 2007) and the very correlation between the two variables (Turnet et al., 2010).

DeLone and McLean (1992) developed the model for Information System Success and refined it later on (DeLone, McLean 2003). The latter presents three dependent variables: Intention to Use, Effective Use and User Satisfaction, as well as Net Benefits, which both influences and is influenced by the other three variables. Information Quality, System Quality and Service Quality are the preceding variables that affect intention to use and user satisfaction. Figure 1 shows the interaction between the variables:

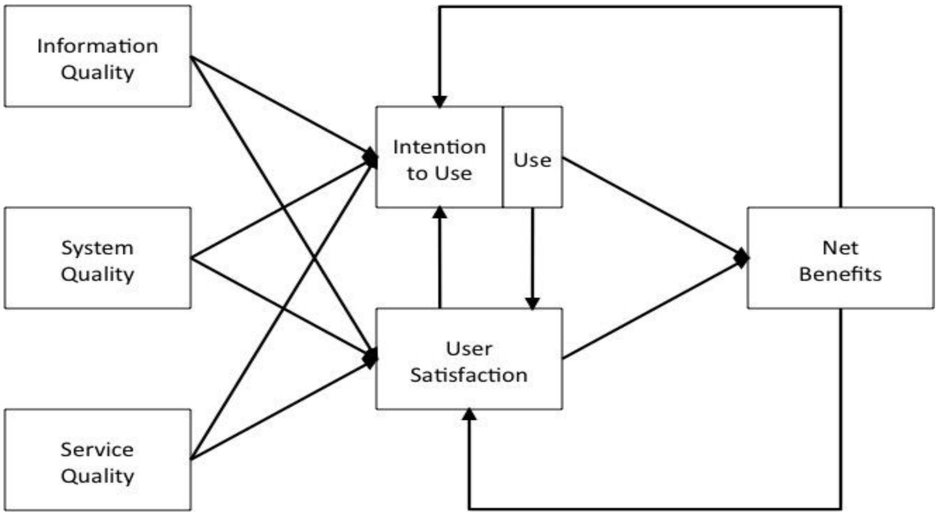

Figure 1. Information System Success (DeLone and McLean, 2003)

DeLone and McLean (2013) proposed a feedback cycle that makes the satisfaction and the received benefits reinforce a continuous use intension as the systems is used. Nevertheless, it is necessary that there were previous elements for the first use of a system. Then, unidirectional causalities may be used as possible approaches to measure this model (Seddon, Kiew 1996; Lin, Wang 2012; Tsai et al. 2012).

System Quality refers to the performance of a system, the hardware efficiency and the processing power. This construct is measured by users' evaluation of the technical capacity and the usability of a system (DeLone, McLean 1992). It is possible to visualize two main categories that define this quality: flexibility and sophistication. The former is the resources' availability and useful tools instead of unnecessary ones, when the latter is related to usability and technology novelty and documentation (Gorla, Somers, Wong 2010).

Information Quality represents how much useful are the system outputs to its users (DeLone, McLean 1992). This construct may present four basic characteristics: information completeness, which means that the system offered all necessary information; format adequacy; updated information; and correct or precise information (Wixom, Todd 2005). Moreover, the information has to be reliable in a way that individuals may consider it useful (Chen, Xu, Whinston 2011).

Service Quality was added in the updated model (DeLone, McLean 2003). The authors used concepts and indices from the model of service quality measuring SERVQUAL (Parasuraman, Zeithaml, Berry 1988) that describes quality as the difference between consumers' expectative from a service and what is really gave to them. Thus, services evaluated as having superior quality are the ones that address or overcome their expected results.

3.1 Adoption of Social Media in Education

An individual could motivate him/herself to adopt a social media by the expectative of meeting someone and resources that may help him/her to solve a problem. An individual could be also influenced to adopt it by family or friends. Chou et al. (2009) described a case of American users of a social media that collaborated in an online group to support people with cancer. The group aimed to help people with experiences sharing among users in similar situations, even if they did not have too much in common or knew each other. According to Quan-Hasse and Young (2010), the necessity of sharing problems is one of the predictors to social media adoption.

In the context of education, a user may use a social media to disclose complaints or to get information more quickly (Xia 2013). Therewith, a student would interact via social media with his/her university and other students to expose problems thinking that he/she is pressuring the institution to solve problems with urgency (Lala, Priluck 2011). This situation may also occur when the university does not offer a good system to receive and manage the students' complaints.

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Quality of information is one of the factors that influence the adoption of a new technology (DeLone, McLean 2003) and it is a students' concern when they are deciding to use a social media (Kim, Sohn, Choi 2011). Additionally, a student values an agile exchange of quality information inside of the learning process (Rinaldo, Tapp, Laverie 2011). The characteristics of a system that was offered by the educational institute are critical to students' decision of using it or not. Among the key factors of success to the implementation of a university's system are: access facility, confidence in the technological infrastructure and service support (Selim 2007).

We may also consider that a student will search for remote means of communication to contact people that are close to him/her (Lin, Liu 2011) and will avoid exchanging information with the ones who transmit the idea of authority and hierarchy. This behavior was observed by Dahlstrom (2012) in social media. It was demonstrated that the student does not feel comfortable to communicate with professors and instructors through this technology. Likewise, the strong presence of faculty in a social media may limit its use (Hanson et al. 2011).

Students may resist adopting the virtual learning environment from their universities, as previous experience and appropriate training are expected in order for this adoption to happen. The lack of these factors probably hinders the usage (Venkatesh, Goyal 2010). When, in the other hand, there is the massive popularity of social media sites like Facebook, which overpassed a billion of users with a great public aging between 13 and 24 years old (CheckFacebook 2013). It seems that an undergraduate student probably has a profile and knows how these social media sites work. Thus, in this scenario, a student does not have to learn a new system's functionalities, when he/she could use platforms that he/she already comprehends to develop academic tasks. It is simpler for students to adopt an additional use purpose in a technology that they have experienced (Venkatesh, Goyal 2010).

4. STUDY MODEL AND HYPOTHESES

In this study we measure quality in users' satisfaction with educational technologies, perceived ease of use and perceived usefulness in social media technologies and in formal channels from an educational institution. Thus, in order for a student to be satisfied with a given system, it is necessary for the system to present availability, reliability and speed (Sun et al. 2008). Furthermore, the system's access ought to be simple and free of technical fails (Manzoor et al. 2012). With that in mind we could propose that:

H1a: The quality of the social media system positively influences the information quality of the social media	*H1b: The quality of the institutional formal system positively influences the information quality of the institutional formal channels*
H2a: The quality of the social media system positively influences the service quality of the social media	*H2b: The quality of the institutional formal system positively influences the service quality of the institutional formal channels*
H3a: The quality of the social media system positively influences the perceived ease of use of the social media	*H3b: The quality of the institutional formal system positively influences the perceived ease of use of the institutional formal channels*
H4a: The quality of the social media system positively influences the perceived usefulness of the social media	*H4b: The quality of the institutional formal system positively influences the perceived usefulness of the institutional formal channels*
H1a: The quality of the social media system positively influences the users' satisfaction with the social media	*H1b: The quality of the institutional formal system positively influences the users' satisfaction with the institutional formal channels*

Even if the communication channels are appropriate and fulfil students' expectations, the information released has to be useful to them. Thus, a system has to provide functionalities that support services to students, as instructions to solve problems or ways to receive them (Kim, Sohn, Choi 2011). Additionally, according to Rinaldo, Tapp and Laverie (2011) great part of the undergraduate students' satisfaction, by using social media, is due to useful information sharing from colleagues – information that was outside of formal institutional channels of their universities. Then, we assume the hypotheses:

H6a: The quality of information in social media positively influences the quality of service of social media

H6b: The quality of information in the institutional formal channels positively influences the quality of service of the institutional formal channels

H7a: The quality of information in social media positively influences the perceived ease of use of social media

H7b: The quality of information in the institutional formal channels positively influences the perceived ease of use of the institutional formal channels

H8a: The quality of information in social media positively influences the perceive usefulness of social media

H8b: The quality of information in the institutional formal channels positively influences the perceived usefulness of the institutional formal channels

H9a: The quality of information in social media positively influences users' satisfaction of social media

H9b: The quality of information in the institutional formal channels positively influences users' satisfaction of the institutional formal channels

It is still necessary that the service has a friendly and organized interface. The service's performance can modify the students' expectations of effort (Saeed, Abdinnour-Helm 2008), as well as the level of support to the electronic institutional channels are critics to students' satisfaction (Selim 2007). Then, we propose that:

H10a: The quality of service of social media positively influences the perceived ease of use of social media

H10b: The quality of service of the institutional formal channels positively influences the perceived ease of use of the institutional formal channels

H11a: The quality of service of social media positively influences the perceived usefulness of social media

H11b: The quality of service of the institutional formal channels positively influences the perceived usefulness of the institutional formal channels

H12a: The quality of service of social media positively influences users' satisfaction of social media

H12b: The quality of service of the institutional formal channels positively influences users' satisfaction of the institutional formal channels

The influence of the perceived ease of use predicts that, the lower the effort to use a technology, the higher is are the benefits to its users (Davis, Bagozzi, Warshaw 1989). Then, the easier the usage of a social media site or an institutional channel, the more convenient they would be to students when performing any actions. Thus, we have:

H13a: The perceived ease of use of social media positively influences the perceived usefulness of academic tasks in a social media

H13b: The perceived ease of use of the institutional formal channels positively influences the perceived usefulness of academic tasks in institutional formal channels

By intending to compare the perceived usefulness and users' satisfaction found through social media technologies and formal institutional channels, we propose four other hypotheses. First, a specific technology applied in educational context, when useful to students, may influence the perceived usefulness of technologies that support academic tasks. When students' performance in these tasks improve by the use of a technology, they are likely to use technologies in general, like social media tools (Luckin et al. 2009) and systems offered by their universities (Pérez, López, Ariza 2011).

H14a: The perceived usefulness of social media positively influences the perceived usefulness of academic tasks in information systems in general

H14b: The perceived usefulness of the institutional formal channels positively influences the perceived usefulness of academic tasks in information systems in general

Satisfied students with a system may tend to appeal to technologies in general looking for problems solution. As already described, a student can use certain social media to share complaints in their networks to pressure their educational institution to give them answers (Lala, Priluck 2011; Xia 2013). Then, we assume that:

H14a: The satisfaction related to social media positively influences the perceived usefulness of academic tasks in information systems in general

H14b: The satisfaction related to institutional formal channels positively influences the perceived usefulness of academic tasks in information systems in general

Research has been applied with users of a Virtual Learning Environment – VLE – from a higher education institution. The VLE holds functionalities like agenda, forum, content sharing by professors (e.g. classes plan, videos, audio, and bulletins), and upload of content. Whereas this tool is integrated with academic and administrative systems' environment, some information as grades' release, school transcripts,

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and enrolment; are synchronized and updated. It is important to mention that this tool is optional to support classes. Professors can choose if they will use it or not, though the grades must be registered through the tool.

The data gathered for this research was analysed quantitatively. The dependent variable, “Perceived usefulness of information systems” is influenced by the variables “Perceived usefulness” of social media and formal channels of information of higher education institutions. These variables were similarly proposed by Davis, Bagozzi and Warshaw (1989) in TAM, and DeLone and McLean (2003) in the Model of Information System Success. We applied the indicators suggested in studies that also based their researches in these models, mainly the study of Xu, Benbasat and Cenfetelli (2013).

The terms used in this study were based in the analysis of interviews previously executed to undergraduate students, and the comments registered after the application of the first version of our questionnaire. Thus, it was possible to increase the concepts comprehension in the next version. Also, the reactions from statements in the questionnaire were presented in a 6-point scale: 1. totally disagree; 2. considerably disagree; 3. little disagree; 4. little agree; 5. considerably agree; and 6. totally agree.

The constructs “Perceived usefulness” and “Perceived ease of use” from TAM (Davis, Bagozzi, Warshaw 1989) were operationalized through four indicators from Xu, Benbasat and Cenfetelli (2013) that were contextualized and adapted to this study. The constructs “Quality of system”, “Quality of information”, “Quality of service”, and “Users’ satisfaction” were gathered from the Model of Information System Success (DeLone, McLean 2003). Users’ satisfaction was measured by four indicators, while each of them was measured through seven indicators.

We printed 120 questionnaires that were distributed in an university campus during three days in December 2013. Just 108 questionnaires were used in the analysis, because seven were not delivered back and five were not completed. Then, composing the population of this study we have: gender - 40 females and 68 males; age – 50 between 18-20 years old, 39 between 21-23 years old, and 19 between 24-26 years old; and area of major – 93 enrolled in Science and Engineering, and 15 in Humanities.

Data collected was analysed with the technic of structural equations modeling - SEM (Hair Jr et al. 2009). We also used the Partial Least Squares - PLS 2.0.M3 in the analysis. This tool presents reliability and strength (Goodhue, Lewis, Thompson 2012). The indicators’ significance was verified by applying Bootstrap using 1000 sub-sets for testing. We also used the software SmartPLS for both models.

Therefore, the analysis was conducted with two independent structural models: the social media and the institutional formal channels. After the partial verification of each model, a simultaneous comparison was made. The contribution of both options was analysed over their general usefulness for academic activities. After that, the scores obtained to usefulness and to satisfaction were compared by means comparison technics. Therewith, T-test was applied in the comparison of means, looking for differences in means with paired or dependent observations (Hair Jr et al. 2011).

4.1 Model Tests

Aiming to validate the variables and the constructs selected to this study, we tested the data in two different ways:

- The convergent validity demonstrates how the scales correspond to constructs measures. The average variance extracted (AVE) has to be greater than 0.5 for each construct (Hair et al. 2009). In the tests all the constructs reached the requisites, since the AVE values varied from 0.6237 to 0.8222, and the composed reliability indexes varied from 0.8323 to 0.9398. This demonstrates that the questions used in the questionnaires were appropriate to measure the constructs.
- The discriminant validity demonstrates if the indicators proposed do not measure their correspondent variables.

Besides that, we verified the factorial load for each indicator in its variable. The values obtained should be greater than 0.70 and also greater than the load of the others variables (Xu, Benbasat, Cenfetelli 2013). Finally, we obtained loads in variables greater than the others and over 0.70. In the Appendices we bring tables with the values obtained for convergent validity, discriminant validity and factorial load.

Figures 2, 3 and 4 show the values of R2 from latent variables and the effects in each relationship between constructs – non-statistically significant relations were omitted from the model. Respectively, we presented the model for social media, for formal institutional channels and the general usefulness. We use: * = $p < 0.5$, ** = $p < 0.01$, and *** = $p < 0.001$.

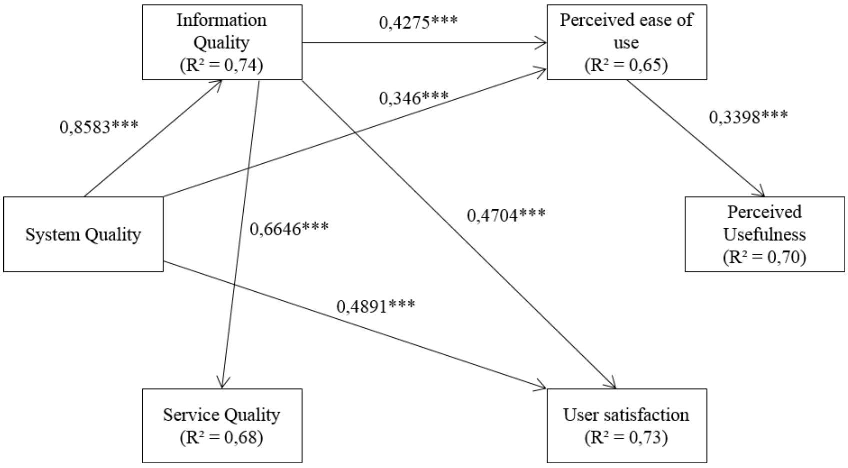

Figure 2. Results from Social Media

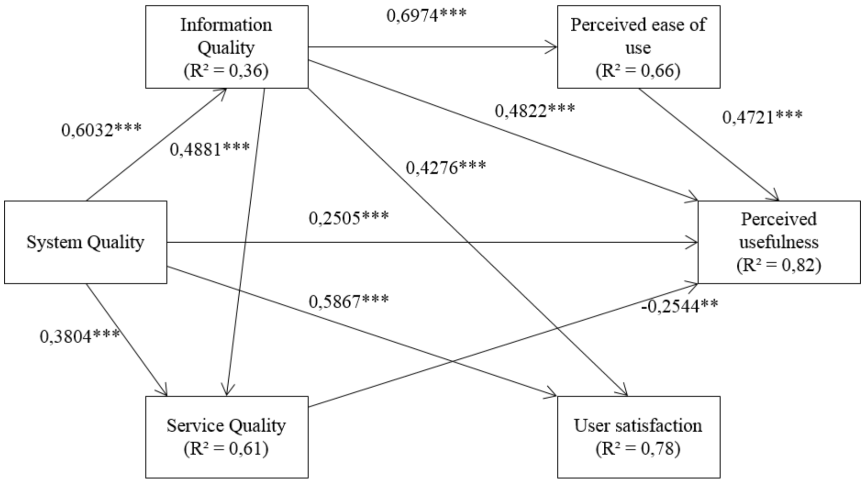

Figure 3. Results from Formal Institutional Channels

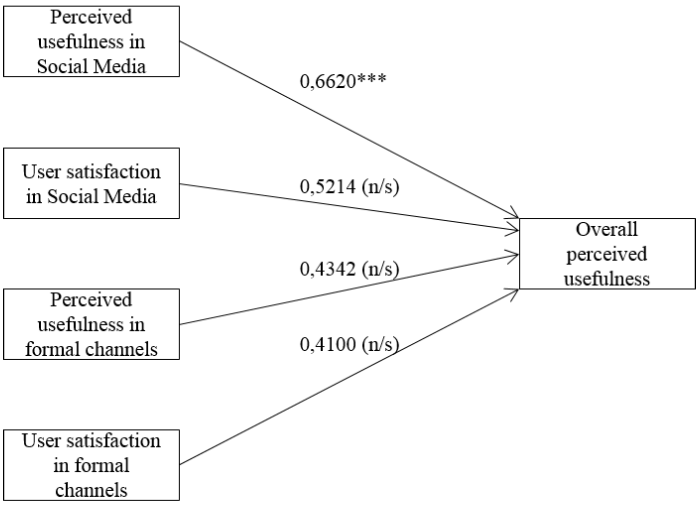

Figure 4. Overall perceived usefulness model

By comparing the models for social media and for institutional channels, we can visualize that the impacts of Service Quality over the Perceived Ease of Use and over User Satisfaction were nonsignificant in any case. In the Social Media model only Information Quality showed significant relation to Service Quality. Perceived Usefulness is impacted only by Perceived Ease of Use, which is influenced for System Quality and Information Quality. In the model for institutional channels of the university, the impact of System Quality and Perceived Ease of Use were nonsignificant. According to the model of Overall Perceived Usefulness, only the relation between Perceived Usefulness in Social Media and the Overall perceived usefulness was significant.

4.2 Comparison of Means

We executed a Student's *t*-test to compare the two means from paired sets, in a way to match users' satisfaction and perceived usefulness related to social media and to institutional channels. Thus, Table 1 presents the results of this test.

Table 1. Tests comparing two means

		Paired differences				
		Mean	Std. Deviaton	Std. Error Mean	t	Sig. (2-tailed)
Pair 1	General usefulness for social media – General usefulness for inst. channels	0.44986	0.92049	0.08857	5.079	0
Pair 2	General users' satisfaction for social media – General users' satisfaction for inst. channels	0,71671	1.0659	0.10257	6.988	0

Therefore we may verify that there is statistical significance between the factors' means. The Perceived usefulness for social media is greater than Perceived usefulness for institutional channels by its mean. Similarly, the mean for users' satisfaction with social media is greater than users' satisfaction with institutional channels. The difference between the means is about 0.45. Even if both means are over 4, we can realize that the students see social media as more useful to academic activities than formal systems and tools from their university. This finding may concern the university administration, since investments have been done in resources acquisition, development and maintenance to provide these institutional channels – while students do not value them as alternative technologies.

On the other hand, the educational institution could take advantage of this scenario by developing strategies to use social media to support academic processes. Perceived ease of use was the factor that impacted significantly the perceived usefulness of social media, so we can understand that students may make the best of this tool by knowing to use it well. Nevertheless it is important to notice that this ease of use is not necessarily related to advanced resources. According to Bennet et al. (2012) reports that not always frequent users of social media will know how to execute activities of high complexity. Therewith, if the university chooses to incentive the use of these resources, it will be necessary to train both students and the employees that will assist them, in accordance with the expected difficult in activities.

The difference between users' satisfaction with social media and with institutional channels is greater (0.716), wherein the satisfaction with social media exceeds the other. It might happen due to the questions' approach, in the questionnaire, about the general users' satisfaction with social media sites and not specifically focused in academic activities. Anyway, there is room for experience improvement of students when using formal institutional channels.

5. CONCLUSION

Analyzing the model for social media, the relations derived from quality of system were similar to the ones that were proposed by Xu, Benbasat and Cenfetelli (2013). Similarly to the results obtained by these authors, quality of information affects positively the quality of service (0.665 to $p < 0.001$). Nonetheless, the influences of quality of information and of quality of service over perceived usefulness were not confirmed in this study. Also, the quality of system did not impact quality of service significantly.

The model for general usefulness presented a single statistical significant impact, the perceived usefulness of social media over the perceived usefulness of institutional channels that remained in R2 = 0.44. Although this relation is tacitly expected in studies like the ones did by Selwyn (2009) and Stanciu, Mihai and Aleca (2012), it was not proposed yet. Thus, future research could consolidate this hypothesis and identify other factors that could be used to explain the general perceived usefulness variable.

It was possible to notice that the students in general feel themselves capable to use better technological resources that they are familiarized with, instead of specific systems that were developed to attend academic activities. Thus, we raise the possibility of students do not wait to need technical support in the future, so it would not be determinant in their general experience and in the usefulness of any of the systems. Therefore, the focus remains in the regular availability, quality of information and intuitive use.

Given the results, the educational institution could adopt one of three lines of action, considering its resources and reality. The first is keeping the divisions between formal channels and informal media, looking for improvement in the quality of systems, their information and TI management. Thus, just spontaneous activities would occur inside of social media sites (Pimmer, Linxen, Gröhbiel 2012). One of the positive sides of this action is that the university may control more its data, against copyright violation, for instance.

The second line of action is to develop mechanisms to integrate the two channels, focusing the participative education and the self-regulated learning through social media as a tool to support the university's politics and systems (Dabbagh, Kitsantas 2012). The advantage is the technics' versatility brought to the institution that would count on a greater number of learning tools, besides students' engagement.

Lastly, the third line of action is the effective appropriation of social media, like virtual learning environments and standards channels for communication with the academic society within the university. Functionalities like forum, teleconferences, instant messages exchange, and archives repository, for instance, could be delivered in this social media (Rinaldo, Tapp, Laverie 2011; Bennet et al. 2012). The advantages of this action are the reduction of costs and the necessity of technical management, whereas systems' reliability risks and data security are assumed by the educational institution. A concern that may arise is the need for constant updating routines to adapt the systems with the institution's operations and in case of obsolescence.

Future research can approach the dependent variables "ease of use" and "perceived usefulness", besides of verify if there is a negative relationship between the quality of service in institutional channels and its perceived usefulness. Deepen the comprehension of general usefulness of educational information systems is another possibility of study, as well as searching for additional variables to explain it.

One of this study's limitations was the low variability of the age group and the questionnaires' application being applied in just one university. Considering that some of the constructs remained with three indicators, it is possible to propose more questions to increase the explanation power of the models.

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INTEGRATE WECHAT WITH MOODLE TO PROVIDE A MOBILE LEARNING ENVIRONMENT FOR STUDENTS

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ABSTRACT

In the information age, learning has become ubiquitous, and mobile learning enabled by mobile technologies is expected to play a significant role in various educational settings. Currently, there exist some limitations on mobile learning from the perspective of technology. The implementation of mobile learning usually depends on the development of applications. In this paper, a whole different and flexible model is proposed, in which the development of applications is replaced by the direct utilization of WeChat. That is, we use WeChat instead of developing a new application to integrate with Moodle to provide students a mobile learning environment. After three years in practice, students become more inclined to log into Moodle directly via WeChat with the evolution of the mobile learning environment. And over a half of surveyed students think the mobile learning environment useful.

KEYWORDS

Learning Environment, Moodle, WeChat, Mobile Learning

1. INTRODUCTION

Nowadays, learning has become ubiquitous, since people are surrounded by mobile technologies in their daily lives(Shin & Kang 2015). The affordances of mobile technologies make timely and active knowledge acquisition through the exchange of learning materials a reality(Woodill 2010; Jones et al. 2013). Therefore, mobile learning enabled by mobile technology is expected to play a significant role in various learning settings(Cheon et al. 2012). However, the availability of mobile technology does not necessarily guarantee that it will be used in an educational setting(Hwang & Chang 2011; Shin & Kang 2015). Similarly, the mere adoption of mobile technology does not ensure students' learning effectiveness(Shin & Kang 2015). Some researchers now begin to place great focus on the integration of mobile technology with Learning Management Systems, namely, the Mobile LMSs, in order to provide a flexible and convenient mobile learning environment for students. More specifically, researchers focus on the use of mobile applications with such systems.

However, in a literature review on mobile learning with learning content management system (Napoleon & Åke 2014), Napoleon and Åke conclude that most of issues addressed focus on learning management systems in general rather than mobile learning management systems or mobile learning content management systems in particular. Though the literature number on mobile LMSs is limited, yet there are some research addressing this issue.

For instance, Huang, Lam, Wong and Chan(2016) developed a mobile version of Learning Management System in order to enhance students' learning experience. They used a Client-Server model, which, in fact, is a very complicated process for many teachers and students. They found that the students' usage of the mobile app is high. By examining students' usage pattern of the mobile app, the suggestions for developers to design and develop mobile app of LMS was proposed.

Admittedly, use of mobile technologies is already widespread in many daily activities of a majority of the world's population, but not yet so in learning process(Napoleon & Åke 2014), partly due to the limitations of mobile devices in terms of application development. Overall, studies on mobile LMSs are mainly about

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technology(Napoleon & Åke 2014). In educational settings the integration of mobile devices with LMSs to create mobile LMSs is implemented by developing applications, while the development and update of applications takes too much time and efforts to achieve. What is more, the use expense for students is tremendously high, because they have to first download the application, then install it, and finally register an account before they can use. And developers have to update the application at times to fix bugs and improve student experience, which takes much time and is a rather complicated process. And developers have to develop applications for different OS such as Android, iOS etc., Technology itself should not be a barrier, it should be a ladder or a bridge. However, apparently, the mobile LMS in educational settings still faces technological obstacles, which raises questions about whether there is a better way to achieve mobile LMS?

In this paper, a totally different model integrating mobile technology with learning management system is introduced. Instead of developing a new mobile version of Moodle, WeChat is utilized and integrate with Moodle to provide students a mobile learning environment, namely mobile LMS. WeChat (WeiXin in Chinese) a mobile instant text and voice messaging communication service, a very popular social networking service in China was developed by Tencent Holdings Ltd. in China on January 21, 2011. It has similar features to WhatsApp to generate both text and voice messages. And it is free to download, install and use(Lien & Cao 2014). It is available on Android, iPhone, Blackberry, Windows Phone and Symbian phones. As of May 2016, WeChat has over a billion created accounts, 700 million active students, with more than 70 million outside of China (as of December 2015) (https://en.wikipedia.org/wiki/WeChat). Almost every college student has WeChat installed in their phone, it is used in different ways ranging from socializing with friends and entertaining to exchanging information and experiences regarding a product or service(Lien & Cao 2014). It has become one of the most widely used social networking service in China(Gao & Zhang 2013).

This papers aims to provide a new way to create mobile learning environment. By integrating WeChat with Moodle, students are able to easily log into Moodle directly via WeChat. And they have the same learning interface and learning experience as on desktop computer because Moodle employs a responsive design structure and supports HTML5. WeChat has its natural advantages in terms of popularity compared with previous model of developing specific application. Therefore, students are more inclined to learn via WeChat because they do not have to download a specific application and what they need to do is just to scan a QR code and subscribe to the learning website (based on Moodle). Apart from the design of the mobile LMS, we also explore students' usage of the mobile learning environment and their perceived usefulness of the learning environment. Therefore, three research questions are asked in this paper:

1. What is the evolution process of the new mobile learning environment we designed?
2. What is the students' usage of the mobile learning environment?
3. To what extent, if at all, do the students think the mobile learning environment useful?

The rest of the paper is organized as follows: Section 2 describes the detailed design process of the mobile learning environment. Section 3 presents students' usage of the mobile learning environment and their perceived usefulness of the learning environment.

2. DESIGN OF THE MOBILE LEARNING ENVIRONMENT

In this section, we describe very comprehensively the design and evolution of the mobile learning environment. To make Moodle be accessed on mobile devices, the following two steps are needed.

1. Introduce responsive theme so that the appearance of Moodle can be adaptive to mobile devices with different OS. There are a lot of responsive Moodle themes in Moodle Community, what we used is a theme titled "Pioneer". One of the features of the theme is that it supports customized banner for every different course so that each course can have a featured banner on top of the course homepage.
2. Besides the appearance, the content of a course needs to be responsive as well. Table 1 is the guidance for teachers to upload different types of resources.

Table 1. Guidance for teachers to upload different types of resources

Resource Type	Requirement
Video	MP4, H.264, AVC, 720p
Audio	MP3, 128k, Stereo
Webpage	HTML5
Courseware Package	HTML5

Before we go into the design and evolution of mobile learning environment we create, a brief introduction to Official Account provided by WeChat is need, the Official Account is one of the unique characteristics of WeChat compared with its counterpart such as WhatsApp, this specific feature allows developers to commit secondary development. And this is the basis of the mobile learning environment presented in this paper.

Official Account works as one of the contacts on WeChat. The basic idea of it is to send group messages to all the subscribers (followers), not only in text, but also in/with video, audio, photos, and URL. Subscribers can read the message and reply if necessary. Official account can also set up auto reply to some keywords. Official Account is categorized into Subscription Account and Service Account.

Subscription Account provides a new information propagation means for media and individuals to build up better communication and management with readers. Service Account provides more powerful business service and student management capabilities for enterprises and organizations, to help enterprises quickly implement a brand-new official account service platform. (https://admin.WeChat.com/cgi-bin/readtemplate?t=ibg_en/en_faq_tmpl&type=info&lang=en_US)

Table 2. The comparison between Subscription Account and Service Account

Functions and Permissions	Subscription Account	Verified Subscription Account	Service Account	Verified Service Account
Messages display	In the "Subscription Accounts" folder	In the "Subscription Accounts" folder	In the friend session list	In the friend session list
Number of group messages	1 everyday	1 everyday	4 every month	4 every month
Basic message receiving/reply API	No	Yes	Yes	Yes
Custom menu at the bottom of chat interface	No	Yes	Yes	Yes
Nine advanced APIs	No	No	No	Yes
Application for WeChat payment	No	No	No	Yes

2.1 Stage1: Preliminary Integration

At stage1, we use WeChat OA Subscription Account as mobile portal for Moodle. Students can scan a QR code to subscribe to an Official Account and receive group messages from administrator on WeChat on their mobile devices every day. The messages include notifications, learning tasks, updates of courses, or some learning related articles. Every time students receive a message, there will be a link named “Read more” at the end of the content for students to click and if click they will be redirected to the Moodle homepage, which includes courses, resources or activities. There is a built-in web browser on WeChat, by which the students can access Moodle without even quitting WeChat. But since this is a preliminary integration, there is no student authentication mechanism for Moodle, therefore the students still need to type into name and password to log into Moodle. The following figure 1 presents the basic structure of the preliminary integration.

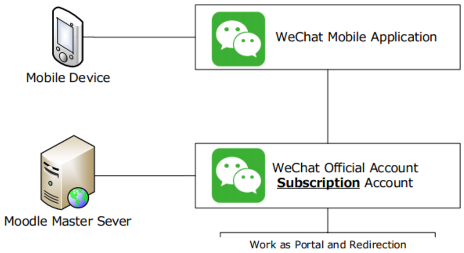

Figure 1. The basic structure of preliminary integration

At stage1, we provide an efficient way to send messages and notifications to our students, and the effective arriving rate is much higher than email since most of our students use WeChat almost every hour and seldom check emails.

On the other hand, there exist several limitations at Stage 1, as listed below:

1. Group Message can only be sent by administrators or teachers manually and only one message can be sent every day.
2. Group Message cannot be customized for each individual student.
3. Lack of student authentication mechanism for Moodle.

2.2 Stage2: Use Service Account for Advanced Integration

WeChat OA Service Account provides a more powerful way to integrate different services. There is a huge amount of APIs for developers in developer mode. So at this stage, we develop a WeChat service and message output plugin for Moodle. And this plugin is used to connect with WeChat Official Account developer service, by doing this, we are able to:

1. **Binding Moodle and students' WeChat profile (student avatar, WeChat OpenID et al.).** There is a unique QR code for each individual student to scan with his or her WeChat the first time he or she logs into Moodle. In this way, Moodle could access the student's WeChat information and finish the account binding. After this, each time when students try to access Moodle from WeChat built-in browser, they could automatically log into the system without authentication.
2. **Sending Templated Messages to individual student automatically.** Service Account provides a more powerful messaging function called Templated Message. The Templated Message is a type of message with a predefined structure with some variables. This kind of message can be customized for each individual student and sent to any specific student's WeChat automatically as many as necessary every day. What is more, different from preliminary integration model, in which messages are displayed in the "Subscription Account" folder, at Stage 2, the Service Account is displayed directly on the friend session list, which makes it more like a normal message from friends and easier to open with fewer screen touches. Thus, effective arriving rate of the message is much higher than that at Stage1. The WeChat service and message output plugin provides students a better way to receive notifications and messages from Moodle. It directly pushes customized information to students' WeChat as Templated Messages. Student can read the message on WeChat, click it if necessary to log into Moodle automatically and access to the related course, resource and activities.

Stage2 is a huge leap forward from Stage1. At this stage, the notifications and messages are not sent manually by teachers, but automatically pushed by Moodle. And the messages are much easier to find since they are displayed on the friend session list. And once students successfully bind their WeChat account with Moodle, they can automatically log into Moodle within the WeChat built-in web browser. They could simply click the Templated Messages and will be redirected to the destinations if they want to have further interaction with Moodle. The following Figure 2 shows the basic structure of advanced integration.

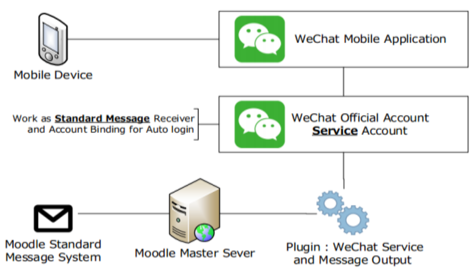

Figure 2. The basic structure of advanced integration

2.3 Stage3: Installing Plugins to Increase Student Viscosity

There are tons of Moodle plugins with various functions. At this stage, we install two essential plugins to increase student viscosity by sending notifications and internal emails.

1. **Plugin "Reminder"** There are already a large amount of notification services embedded within the standard Moodle package. But there is still a long way to go before it reaches perfection. "Reminder"

provides five new types of event notifications: Site, Student, Course, Group, and Activity events. Administrators can configure how many weeks, days or even hours in advance to send the event notifications. Once the administrators or teachers add any date and time requirements to the site, courses or activities, Moodle will automatically create an event in the calendar, and students can create event for themselves on the calendar as well. The Reminder plugin will automatically send notifications in advance. And this kind of notifications is sent to a specific group of students by WeChat Templated Message.

2. **Plugin "Email"** The Moodle internal message system can send messages to any student over the site, which can cause tremendous disturbances to students since there is a lack of traffic management. What is more, the message system provides only plain text message editor, and is unfriendly for sending attachments. The "Email" plugin is an excellent alternative to solve this problem. With this plugin, students can only send emails to each other within the same course or even the same group. Students can send email without knowing the actual email address of the others. The Email is sent by names, groups, and teachers can send to a group of selected students within a course easily with attachments. The interface of this internal Email is clear and resembles normal email service with a powerful text editor which supports the modification of text font, size, and audios, videos, pictures and links can also be embedded. What's more, the internal email can push a notification in the form of Templated Message which can be read directly on students' WeChat.

With "Reminder", Moodle can automatically notify students for any event that has been set. "Email" can help administrators or teachers to send messages and attachments manually to a selected group of students. The Templated Message helps push notifications to students' WeChat, thus increasing student viscosity. Figure 3 shows the basic structure of this integration after installing "Reminder" and "Email".

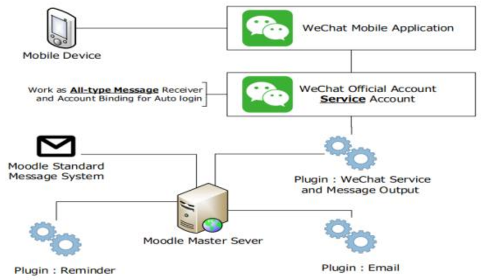

Figure 3. The basic structure of the third integration after installing "Reminder" and "Email"

3. IMPLEMENTATION OF THE MOBILE LEARNING ENVIRONMENT

To examine students' usage and their perceived usefulness of the mobile learning environment we proposed, we collect data from *Baidu Statistics* and *questionnaire*. Data stored in *Baidu Statistics* is used to explore students' usage of the learning environment and the *questionnaire* is aimed to check students' perceived usefulness on the mobile learning environment.

3.1 Context

Zhaoqing Medical College is located in Zhaoqing City, Guangdong Province, China and has been adopting Moodle since 2007 in order to support online teaching and learning. In around 2013, due to the immediate popularity of WeChat in China, we tried to integrate WeChat with Moodle to create a mobile learning environment for students. *Baidu Statistics* is a professional website traffic tracking and analyzing tool developed by Baidu, Inc. By using this tool, some basic information about students accessing the website can be obtained, such as the types of devices they are using, what kinds of web browser they are using and what time they access the website in a day etc.

To answer the third research question, we asked students' perceived usefulness of the mobile learning environment. In fact, the question is from a questionnaire on students' learning style. The students who completed the questionnaire are in their first and second year and finally we collected 3690 feedbacks.

3.2 Students' Usage of the Mobile Learning Environment

As shown above, the evolution of our mobile learning environment is divided into three Stages, Stage 1 is from December 2014 to November 2015, Stage 2 is from December 2015 to April 2016 and in May 2016 the development of the learning environment came into Stage 3. The following Table 3 presents the percentage of different devices that students use to access Moodle and total pages viewed in different stages.

Table 3. Percentages of devices used to access Moodle and pages viewed in different stages

	Total PV	Computer	Mobile Device
Stage 1	7705722	68.87%	31.13%
Stage 2	6318410	62.66%	37.34%
Stage 3	892956	63.40%	36.60%

At Stage 1, the percentage of mobile devices is 31.13%, 37.34% at Stage 2 and 36.60% at Stage 3. Overall, from the figures we can identify that the percentage of mobile devices used to access Moodle is increasing.

Table 4 shows students' specific way to access Moodle, from the Table it can be found that the percentage of WeChat at Stage 2 is higher than that at Stage 1, which means that students are getting more accustomed to log in directly via WeChat, but the percentage is rather smaller compared with that of "Direct Visit". However, the "Direct Visit" figure is actually not what it shows. At stage 1, we send students group message with a link named "Read more" at the end of message, and by clicking the link, the students will be redirected to Moodle. *Baidu Statistics* can identify the whole process and regard it as access via WeChat instead of "Direct Visit'. At stage 2, a Moodle plugin is developed to integrate with WeChat Service Account. The mechanism is much different from that at Stage 1. The redirection process at Stage 1 is avoided at Stage 2. Because of the customized Templated Messages are pushed by Moodle, if students access Moodle via built-in WeChat browser, then the traffic generated in this process will be categorized in the "Direct Visit" rather than in WeChat. Therefore, in fact, the percentage of access via WeChat at Stage 2 is actually much higher than 8.22%.

Table 4. Students' specific way to access Moodle

	Average Monthly PV	Direct Visit	Search Engines	WeChat	Email
Stage 1	642143	59.26%	28.6%	6.58%	0.3%
Stage 2	1263682	54.18%	36.23%	8.22%	0.02%
Stage 3	861424	62.07%	33.79%	2.31%	0.05%

Figure 4 presents students' daily access to Moodle by mobile devices and computers in the three different stages, from which we can see that the percentage of mobile devices is lower in contrast to that of computers. What is motivating is that the percentage of mobile devices in Stage 2 is increasing, partly because the more advanced integration introduced above and students getting used to accessing Moodle directly via WeChat. Stage 3 has only been available for students for less than two months, therefore it is sound that we neglect the usage and access in this stage. From 6 to around 9 in the morning, the percentage of mobile devices is higher than that of computers, most of students wake up at this time and check their WeChat messages. Though some students' primary intention is not to check the messages sent by teachers, yet WeChat does offer the possibility for students to check messages from teachers after they finish reading messages from other sources. And this possibility barely exists in case we integrate specific application instead of WeChat with Moodle.

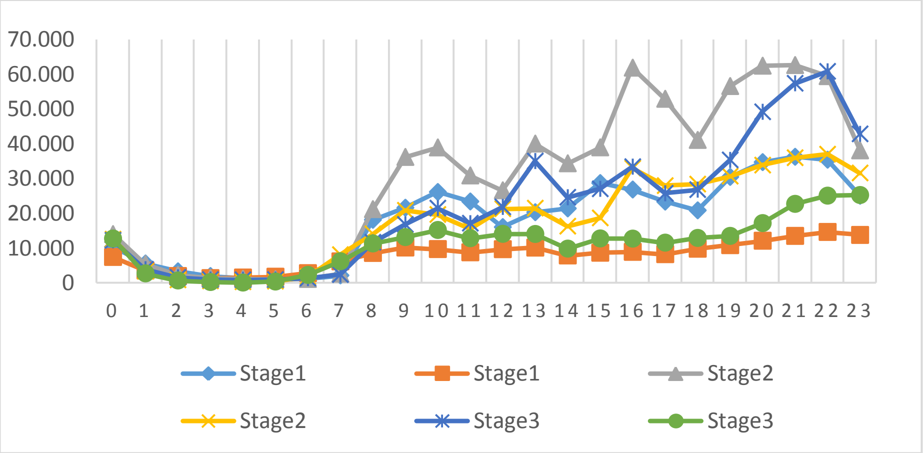

Figure 4. Students' daily access to Moodle by mobile devices and computers in the three stages

3.3 Students' Perceived Usefulness of the Mobile Learning Environment

In order to learn students' perceived usefulness of the mobile learning environment, we conducted a survey on 3690 students in Zhaoqing Medical College. We use a 5-point Likert scale(Dawes 2008; R. R. Gliem & J. A. Gliem 2003) to examine students' perceived usefulness. The item is "I think the integration of WeChat with Moodle is very helpful for my learning". However, it should be noted that the item we presented here is only part of a complete questionnaire. Figure 5 shows the results of students' perceived usefulness of the mobile learning environment.

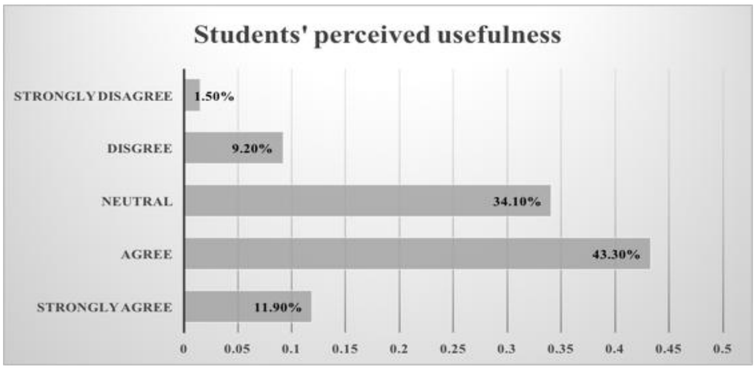

Figure 5. Students' perceived usefulness of the mobile learning environment

From the result we can find that over a half of students think the integration of WeChat with Moodle very helpful for their learning.

Besides, during our daily teaching, we have informal interview with students asking their opinions about our mobile learning environment, most of the students think highly of it. For instance, some students state that "compared with other way of accessing Moodle, WeChat is more convenient and useful".

4. CONCLUSION

In this paper, we propose a totally different way of creating mobile learning environment. Rather than developing a new application, we integrate WeChat with Moodle instead. The new integration is more convenient for both teachers and students. The design and evolution process can be categorized into three different stages, namely, Stage 1, Stage 2 and Stage 3.

At Stage 1, WeChat OA Subscription Account works as mobile portal for Moodle. Students can subscribe to an official account and receive group messages every day by scanning a QR code with WeChat. But since there is no student authentication mechanism for Moodle at this Stage, the students would have to type into name and password to login to Moodle. At Stage 2, we make major updates by binding Moodle and students' WeChat profile together, thus making the automatic login without authentication a reality. What is more, we replace Subscription Account at Stage 1 with Service Account. A more powerful messaging function called Templated Message is contained in Service Account. More importantly, the Service Account is displayed directly on the friend session list, which makes it more like a normal message from friends and easier to open with fewer screen touches. Therefore, effective arriving rate of messages is much higher than that at Stage 1. At Stage 3, we install two essential plugins to increase student viscosity by sending notifications and internal emails. With "Reminder", Moodle can automatically notify students for any event that has been set. "Email" can help administrators or teachers to send messages and attachments manually to a selected group of students. The Templated Message helps push notifications to students' WeChat, thus increasing student viscosity.

From the data stored in *Baidu Statistics*, it is found that with the evolution of mobile learning environment, students become more inclined to log into Moodle directly via WeChat. And over a half of the surveyed students have a high perceived usefulness of the mobile learning environment.

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SCALING A MODEL OF TEACHER PROFESSIONAL LEARNING – TO MOOC OR NOT TO MOOC?

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ABSTRACT

This paper describes an innovative model of teacher professional learning that has evolved over a decade. Working in a range of different school contexts, in conjunction with an ongoing engagement with the research literature, has enabled the development over three phases of a robust, yet, flexible framework that meets teachers' expressed needs. At the same time, the framework helps to shift their pedagogical orientation, as the learning design supports school-focused, job-embedded teacher professional learning, which challenges more traditional instructional environments by infusing digital technologies and other elements of 21st century skills into teaching and learning. Building on this experience the paper then reports the most recent phase of designing and developing a Massive Open Online Course (MOOC), which could potentially enable the massive scaling up of access to this already validated model of teacher professional learning. Finally, we discuss the importance of maintaining key elements and signature pedagogies in the design of MOOCs for teacher professional learning, and conclude with early lessons from this latest work in progress.

KEYWORDS

Teacher education, 21st century skills, MOOCs, peer learning, learning design, ICT

1. INTRODUCTION

Today's world is rapidly changing. We live in a period of major technological change where a number of grand challenges such as climate change, unsustainable population growth and the future of work require critical thinking and creative solutions. More than ever, we need to ensure that all students have the knowledge, skills, abilities and competencies to be successful in the 21st century. A range of "21st century skills" (often referred to as "Key Skills" or "Key Competencies", (e.g. ETA, 2010; OECD, 2005), have been identified as necessary to prepare students to live, work and thrive in a digital society. They include skills such as critical thinking and problem-solving, communication, collaboration, self-regulation and information management (e.g. Binkley et al., 2012). The ability to use digital technology effectively and reflectively is identified as a key competence in these initiatives, each of which stresses the potential of technology to transform the learning experiences of students by helping them become engaged thinkers, global citizens, and active learners in collaborative, social learning environments (Butler & Leahy, 2015).

Teachers in today's classroom must not only be prepared to use technology; they must also know how to use technology to support student learning. According to UNESCO (2008), these have become "integral skills in every teacher's professional repertoire" (p.1). The importance of developing these skills cannot be emphasised enough, especially when one considers that teacher quality, not funding, has been found to be the determinant factor among conditions that support the performance of the world's best education systems (Barber & Mourshed, 2007). How then do we go about ensuring that teachers have these skills? We know that teaching and learning is complex. Therefore, it should not be a surprise that efforts to integrate new digital technologies add to this complexity. In addition, we know that the introduction of new technology into a learning environment does not by itself lead to changes in learning outcomes (Dynarski et al., 2007). Nor does it mean that educators will meaningfully integrate technology into teaching and learning (e.g. Russell et al., 2003) or develop innovative teaching practices (Fullan & Langworthy, 2014). Instead, past experience has taught us that new tools can easily be used to reinforce or perpetuate traditional teaching methods (e.g.

Law & Chow, 2008). Moreover, what the research shows is that how technology is used determines whether or not its use affects learning outcomes (e.g. Higgins et al., 2012).

There is growing consensus among education leaders and researchers worldwide that both teaching and learning need to change to help students develop the skills they need to succeed in the complex, globally connected world of the 21st century (e.g. Ananiadou & Claro, 2009). Specific goals for 21st century teaching and learning are now commonplace and while these goals vary across countries, common themes include problem-solving, teamwork, and the use of technology to support more impactful learning. Despite this, teachers rarely have access to specific guidance or support on how to make 21st century goals come to fruition in the classroom. There is a significant gap between the goals for 21st century teaching and learning and well-designed teacher professional learning programmes to develop these skills. Faced with this reality, the challenge is to design professional learning experiences for teachers that enable them, in turn, to design learning activities that enable their students develop the dispositions, skills and competencies required to live and thrive in the 21st century.

2. DEVELOPMENT OF A TEACHER PROFESSIONAL LEARNING SCALABLE MODEL

In this paper and against this backdrop, we report the development of a scalable model of teacher professional learning in Ireland, which has been developed and has matured across three phases, over nearly a decade. We begin by outlining how this approach was developed in a single secondary school engaged in a global project in Phase 1 (2007–2010) and then how building on the success of Phase 1, the initiative expanded to district level in Phase 2 to include eight more schools (2009-2013). Across both phases, the programme of professional learning developed was school-focused, job-embedded and directly related to the teachers' experiences along with their stated needs and interests. In response to an expressed desire among school leaders and teachers alike, it was also directly linked to a university postgraduate accreditation process (Butler & Leahy, 2010; 2011; 2015). Finally, Phase 3 concerned the design and development of a MOOC which has the capacity to engage teachers globally (2014-to date).

2.1 Phase 1 - Designing a Teacher Professional Learning Framework

The 'Innovative Schools Programme' (ISP) was a Microsoft Partners in Learning initiative that sought to support teachers around the world as they transformed traditional schools into providers of innovative learning experiences, that prepare students for the 21st century. This initiative was implemented in different ways across 12 pilot schools worldwide, as each school was encouraged to select reform goals that were appropriate for its local and national educational context. In Ireland, the focus was placed on the integration of digital technologies into teaching and learning in the secondary sector. The main objective was to design a framework for the professional learning of teachers in a secondary school. This approach was considered particularly important in Ireland because rigid state standards and a traditional exam-based system of education at secondary level constrain teachers' ability to change their instructional practices. It leaves them with little time or flexibility to introduce new ideas or practices. The school, the ISP program manager in Ireland and the national evaluators (Butler & Leahy, 2010; 2011; 2015) saw the ISP as a means to make a very rigid system more flexible through the use of digital tools.

Prior to the ISP, training had been provided to teachers in the school in the use of a variety of applications and a range of hardware. There was also a strong culture of peer support within the school. However, the training tended to be "technocentric" as the focus was on the "technology" and the acquisition of skills and the development of products for teaching rather than reflection on possible new pedagogical practices.

As national evaluators, Butler & Leahy realised the need not only to work closely with teachers and school management to shift this focus but also to concentrate on the teachers' beliefs and values as the starting point. This was because research evidence has repeatedly identified a teacher's pedagogical orientation as a dominant factor in how they use ICT in their classroom (e.g.; Law et al., 2008; Shear et al., 2011). Research has also demonstrated that professional development programmes are most effective when they are embedded into teachers' professional lives and communities within the school (Darling-Hammond et al., 2009), are focused explicitly on local goals for student learning (e.g. Darling-Hammond, 1993), and grounded in collective discussions of classroom practice (Warren Little, 2003). To this end, a key feature of the professional learning programme was that it was both directly related to the teachers' stated needs and experiences and anchored in the meaningful context of their own classroom practices. Previous experience in developing a model of professional learning had led to the realisation that in order to change classroom practice teachers need to ask questions about their existing classroom practices (Butler, 2004). To do this, it was critical that the teachers in the school were challenged to question their practice. The Learning Activity/Student Work (LASW) framework developed by Stanford Research Institute as part of the ISP (Shear et al., 2009) provided this context. The framework enabled the teachers to design learning activities in which they embedded 21st century learning principles, develop the meta-language used to describe such learning environments as well as reflect on their teaching and the assignments they set their students (Butler & Leahy, 2010; 2011; 2015). Finally, as requested the programme was directly linked to a university postgraduate accreditation process.

2.2 Phase 2 – Evolution of the Peer Coaching Model

Observing the changing nature and more innovative practices during Phase 1 that occurred as a result of engagement in the professional learning programme, management requested that the programme be expanded to district level. In consultation with Butler & Leahy, they decided to invest funding into the professional learning of a group of teachers in schools across the district. It was perceived that these teachers would become peer coaches and promote the creative integration and use of digital technologies in teaching and learning among teachers at their schools. The target group identified to become peer coaches were the ICT coordinators from schools across the district. Traditionally, the role of ICT coordinator was associated with ensuring that hardware was in working order or at best supporting the development of teachers' technical ICT skills. However, in agreement with district management, this role was redefined whereby ICT coordinators were now expected to support innovative and emerging new pedagogies and technologies to facilitate student learning and the development of twenty-first century skills. Management also requested that formal accreditation would continue to be a feature of the programme. In response, the Digital Learning Peer Coaching (DLPC) programme was developed with 12 teachers participating over two school years (2009-2011).

2.3 Impact of the Professional Learning Model

Across Phase 1 and 2, teachers, school leaders and management initially tended to view digital technologies as tools to support traditional practice. However, through participation in the programme, their understanding shifted and they began to perceive digital technologies as tools that facilitate more progressive classroom practices and the development of their students' 21st century skills. Evidence of this change and enhanced quality of education is found in the national evaluation reports of the ISP (Butler & Leahy, 2008, 2009) as well through analysis of the coursework and final dissertations produced by teachers participating in the postgraduate diploma (Butler & Leahy, 2015). Together, they demonstrate that the overriding impact of the programme was to move teachers "out of their comfort zones" (Butler & Leahy, 2015). Traditional assumptions, beliefs and classroom practices of all the participating teachers, coaches and coaching partners were challenged and they began to focus on more innovative approaches to student learning with increased integration of digital technology in the classroom. This was evident by the emergence of the following trends in classroom practices:

- Student-centered learning
- Project based learning rather than discrete lesson plans
- Students working collaboratively in groups rather than individual learning
- Focus on learning not on subject "content"
- Awareness of / designing lessons with opportunities for students to develop 21st century skills
- Increase in teacher confidence to use a greater range of pedagogical strategies / digital technologies
- Collaboration across and between subject departments / ripple effect

The shift in pedagogical orientation along with increased use of digital technologies in learning and teaching had a positive impact on student learning, resulting in learners:

- taking control of their own learning
- having greater ownership of the learning activities
- demonstrating more engagement / participation
- increased collaboration
- being active rather than passive in their learning
- taking on new leadership roles

This change is encapsulated by a peer coach as follows:

> I really believe that during this process we have analysed these 21st century skills, probed how we can bring them to the fore in our learners and prove that they possess these skills while using ICT to make learning more interactive, exciting, independent and engaging. (Butler & Leahy, 2015)

From this, it is apparent that the model of professional learning resulted in a shift in the pedagogical orientation of the teachers who were involved in the programme. It enabled the participating teachers to design learning environments which were more student-led and characterised by the use of a range of digital technologies supporting an enquiry process that demanded the use of essential skills such as knowledge construction, problem-solving and innovation, self-regulation, skilled communication and collaboration. This is a significant move away from the narrow exam drive focus towards a knowledge deepening approach (UNESCO, 2008, 2011).

2.4 Problems of Scalability

Although the developments and findings outlined above were encouraging, the issue of scalability has become increasingly problematic. Policy decisions in relation to the development of a range of "21st century skills" (NCCA, 2009) as well as the ability and the need to use digital technology effectively and reflectively in Irish schools, has led to ongoing demands to extend the model of professional development. In particular, the launch of the Digital Strategy for Schools (DES, 2015) identifies "a need to ensure that ALL teachers are equipped with the knowledge, skills and confidence to integrate ICT into their practice" (p. 7). There has also been ongoing international demand to facilitate workshops, many of which could not be sustained (e.g. Finnish Board of Education, Microsoft's Global Educator events, Jordan's Teachers' Institute). As a way of addressing this problem of scalability, the possibility of using a MOOC format was considered.

2.5 Phase 3 – Scaling the Model of Professional Development

The research literature to date suggests that MOOCs are most appropriate for those learners who already hold an undergraduate college degree or higher (e.g. Ebben & Murphy, 2014). While MOOC completion rates are low, prior level of schooling is considered a predictor of achievement (Greene, Oswald, and Pomerantz, 2015); thus suggesting that teachers completing a MOOC for professional development might be more likely to complete it rather than other participants (Hodges et. al., 2016). In fact, Lauillard (2016) considers the use a MOOC as a medium for the continuing professional development of teachers as "a perfect fit" (p. 7). Therefore, coupled with the growing number of open solutions targeting schools (e.g. ICEF Monitor, 2016; Vivian et. al, 2014), it was a logical step to investigate the use of a MOOC to scale the model of teacher professional learning we had developed to date.

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3. WHY A MOOC?

Although there are issues around completion and accreditation, MOOCs are now recognised as a valid form of professional learning in a number of professions. They have the potential to attract large numbers of learners, particularly highly qualified professionals to participate in free education programmes (Laurillard, 2016).

MOOCs can be defined as "typically involving structured and sequenced teacher-led activities (e.g. videos, readings, problem-sets) coupled with online assessments and usually some venue for student interactions such as a discussion forum" (Greene et al., 2015, p.927). Participants can thus interact with the content at their own pace over a period of time (Jobe, Ostlund and Svensson, 2014). When accessed in this way, MOOCS are referred to as xMOOCs. In contrast, MOOCs which place more emphasis on connecting with learners through blogs and forums rather than on structured resources are referred to cMOOCs (McGreal et al., 2013 in Jobe, Ostlund and Svensson, 2014). They are designed so that learners can learn "through practice (construction and responding to feedback), discussion (comments and conversations) and production (negotiating an output for evaluation by others), making it a complex and valuable learning process" (Laurillard, 2016; p. 16). There is a growing interest in how MOOCs can support teacher professional learning (e.g. Hodges, Lowenthal and Grant, 2016). In this regard, the xMOOC format may work well at scale by providing a mix of presentations such as videos and digital resources, automated assessment, peer-assessed assignments and peer discussions (Conole, 2013 in Laurillard, 2016). Thus, a big part of developing an xMOOC is the design and development of such assets (i.e. video, presentations, discussion topics etc.), as ultimately participants will interact with these during the course. However, the likelihood is that these assets may not provide sufficient opportunities for teachers to interact in a meaningful way with the content or with other learners. The challenge is therefore to design learning experiences that support large numbers of teachers to engage in a model of co-learning which as stated by Avalos, 2011 involves:

> networking and interchanges among schools and situations and is strengthened in formalised experiences such as courses and workshops that introduce peer coaching or support collaboration and joint projects ...the lesson learned is that teachers naturally talk to each other, and that such talk can take on an educational purpose. (Laurillard, 2016; p.3)

Cognisant of the research and taking into consideration our experiences in Phase 1 and 2, we strove to design a MOOC that could reach large numbers but also provide opportunities for teachers to learn through practice, discussion and production (Laurillard, 2016). In this sense, we wanted teachers both to try out ideas in their classrooms and report back on their experience. We wanted to promote critical reflection and discussion as well as providing opportunities for teachers to share ideas and resources. Incorporating these elements would we believed result in scaling the model of teacher professional learning we had developed to date, that is, contextualised and meaningfully rooted in classroom practice. We are critically aware that that a community of practice needs to be built up around a MOOC, as against individuals just working through things on their own.

3.1 Towards Building a MOOC

After a period of research and negotiation, funding was secured from Microsoft to design a MOOC. The aim of the MOOC, which we entitled the 21CLD MOOC, was to scale the model of professional learning developed in Phase 1 and 2. It would thus enable teachers to examine and change their own classroom practices, as they relate to innovative uses of digital technologies to support their own and their students' learning and the development of 21st century skills. Working with partners from the wider university and in the SME sector, we accordingly began the design process.

In keeping with Phase 1 and 2, a central feature underpinning the MOOC design was the tenet that when teachers' pedagogical orientations are driven by understandings of 21st century learning, they take on a more facilitative role, provide student-centred guidance and feedback, and engage more frequently in exploratory and team-building activities with students (Shear et al., 2011). Findings in Phase 1 and 2 were that the changes observed in the teachers' pedagogical orientation and the emergence of a culture of self-evaluation among the teachers was directly attributed to the use of the Learning Activity/Student Work (LASW) framework (Shear et al., 2009) which was introduced as part of the coursework. Comprising of a set of rubrics that describe key dimensions for innovative teaching and learning: knowledge construction, collaboration, problem solving and innovation, self-regulation, skilled communication and the use of ICT for learning; the LASW framework enabled the participating teachers to design learning environments which were more student led and characterised by the use of a range of digital technologies supporting an enquiry process. Teachers' claimed the framework had both increased their understandings of the principles underpinning 21st Century learning and also led them to reflect on their own understandings and assumptions about the learning environments they designed for their students.

> I look at the assignments I give the students in a different way…. My objectives are now to improve student engagement and understanding. I want the students both to exercise logical and creative thinking and at the same time gain 21st century skills such as problem-solving, collaboration and self-evaluation. (Butler & Leahy, 2015, p. 341)

To this end, rooted in the LASW Framework (now called 21CLD), we designed an eight-module, self-directed course to be a core component of the MOOC design. These modules explore what learning looks like in the 21st century and how innovative teaching practices can support student learning to develop the key 21st skills of collaboration, knowledge construction, self-regulation, problem-solving and innovation, skilled communication, and the use of ICT for learning. As well as defining, explaining and illustrating each of the skills, an integral part of each module is an 'in action' video in which teachers from across the world showcase how they have embedded a specific skill in their classrooms. Each of eight teachers from countries such as Finland, Canada, South Africa and Australia designed extended learning units for their students which focus on the development of 21st century skills while also embedding the use of a range of digital technologies. As well as illustrating a particular skill in action, these videos are also intended to be the focus of discussions in which participant teachers analyse and reflect on the learning observed in each classroom. Teachers are also asked to share ideas as to how they could design learning activities for their own classrooms, which incorporate the development of 21st century skills.

While the modules we developed provided the content for a MOOC that could support the process of self-reflection on classroom practice, we face two key challenges in the implementation of the 21CLD MOOC. First we are concerned about how to maintain focus on the job-embedded, needs driven nature of the original model of professional learning. Cognisant of the reality of what works in one school does not necessarily work in another, in Phase 1 & 2 we had provided opportunities for teachers to debate and contextualise how to design learning activities for students which embedded the use of digital technologies as well as the development of 21st century skills.

> But, to get people to think about assignments, project based learning…to open people's minds, and the reason why it was so good from the professional learning point of view was because all the different subject areas had something different to bring to the table… people realised that although they see themselves as teachers of a particular subject, they're not really. That we're all part of the one group, and that we're all basically should be aiming towards this 21st Century education providing that for our students, as opposed to just teaching English, Irish, Maths or whatever it happens to be. (Butler & Leahy,2015, p.330)

We had also provided the structure to enable strong collaboration:

> It afforded me the opportunity to engage with my peers in a very meaningful way. We had never engaged in deep discussion on the teaching and learning of our subject content or on the pressing need to update our methodologies and perceptions…. (Butler & Leahy, 2015, p.342)

The second challenge we face in the implementation of the 21CLD MOOC, is therefore how to recreate the collaborative nature of peer-coaching and develop the communities of practice that can sustain the culture of self-evaluation which occurred in Phase 1 & 2. In an effort to address these challenges, we have built into the design of each module some opportunities for "more collaborative and constructivist engagement with teachers" (Laurillard, 2016, p.3). For example, with the use of forums, rather than the typical MOOC forum format which tend to be used for question-and-answer (Hollands & Tirthali, 2014), we have framed focused questions related to the design of learning activities to promote what Laurillard (2016) refers to as

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"co-learning". However, for this co-learning to be meaningful we are aware that the forum discussions will need to be moderated and supported by other means such as synchronous "live" sessions as well as working online asynchronously. In addition, and in keeping with "the cMOOCs focus on community building, social interaction [and] peer review" (Jobe et al., 2014, p.1581), we want participants to be able to work in peer groups, sharing experiences, ideas and expertise. This also aligns with our job embedded approach that recognises the value of the experience and expertise that teachers can offer each other (Butler & Leahy, 2015).

Finally, the notion of a MOOC is constantly evolving. It has recently been claimed that a mandatory design principle for a MOOC to be successful as a form of professional teacher development is that it offers a certificate/digital badge that clearly recognizes and validates the accomplishments of a learner. Indeed, a preferred design element in a massive course would even be university accreditation (Jobe et al., 2014, p.1583) as this would address the issue regarding the acceptance of accomplishments by employers. Some (see Bang et al, 2016) are proposing that layers be built on top of existing MOOCs so that different audiences can have different experiences. Using this concept and incorporating it with our own experiences of designing the professional learning model in Phases 1 & 2 we have envisioned how a series of layers could be built around the 21CLD MOOC assets (see Figure 1).

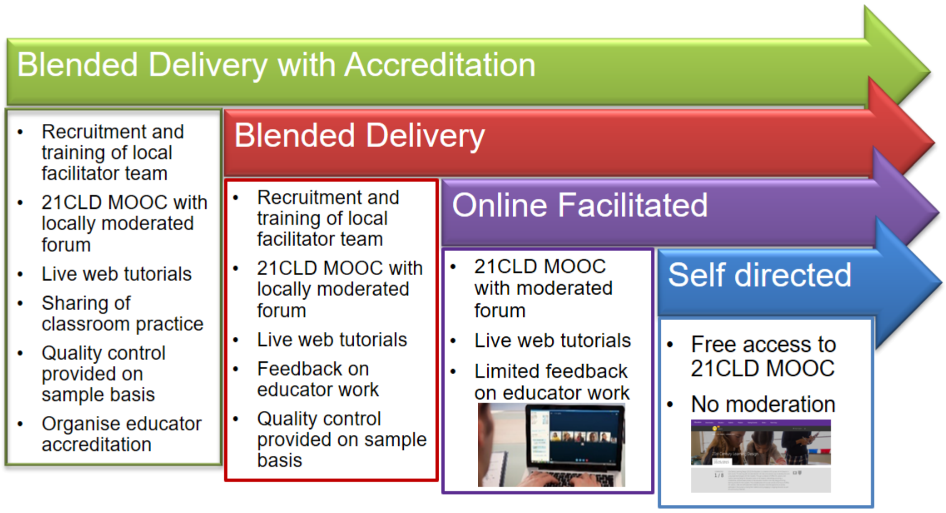

Figure 1. Possible ways that the 21CLD MOOC can be developed

Constructing a series of layers will ensure that teachers can interact with the MOOC assets in a variety of ways, ranging from self-study to a blended accredited model and this will very much depend on what type of learning experience they wish to have. To this end, we are currently working with several potential partners to build a range of social structures and supports to ensure the scalability of the 21CLD MOOC model by embedding it within the existing structures across the education landscape in Ireland. In addition, discussions are already advanced within the university to extend the previously accredited face to face model to the 21CLD MOOC structure.

4. CONCLUSIONS

Currently, any teacher can access the MOOC assets developed for the eight modules of the 21CLD course on the Microsoft Educator Platform and over 10,500 have done so in the five months since its launch in February 2016. However, the content has not, as yet, been designed or hosted on a MOOC platform. The next phase of development is to take these assets and to relocate them on a MOOC platform where we can build learner experiences that relate to the layers outlined in Figure 1. Ultimately, we want to design a MOOC learning experience that resembles the deep professional learning experiences observed in Phase 1 and 2, so that we "create equitable, dynamic, accountable and sustainable learner-centred digital learning ecosystems" (Incheon Declaration Education 2030, 2015). Among the greatest challenges going forward will be to design the social supports within the MOOC structure to sustain the collaboration, dialogue and ongoing reflection that is necessary for the changes in pedagogical orientation and classroom practices (which were observed across phases 1 and 2). In this sense, although the 21CLD resources are now available to a world-wide audience, we have still to develop ways that the school-embedded, job-focused model of teacher professional learning can be scaled effectively so that the teacher professional learning experience is contextualised and rooted in classroom practice. The need for this transformation from simple "resources" (or artefacts) into a dynamic, ongoing "process" is the next challenge in the development of this MOOC to support a scalable and sustainable model of teacher professional learning.

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A PRELIMINARY STUDY ON BUILDING AN E-EDUCATION PLATFORM FOR INDIAN SCHOOL-LEVEL CURRICULA

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ABSTRACT

In this study, we explore the possibilities of utilizing and implementing an e-Education platform for Indian school-level curricula. This study will demonstrate how the e-Education platform provides a positive result to the students' learning and how this tool helps in managing the overall teaching processes efficiently. Before describing the overview of this e-Education methodology, the current Indian education policies, and the curriculum implementation strategy in School-Level education will be discussed. We will extend our opinions on current state-of-the-art e-Learning methodologies employed in Finnish educational institutions and pursue a comparative study on Indo-Finnish education systems. In this paper, our views on the appropriateness of the developed platform (*ViLLE* e-Education Platform) towards Indian elementary-level curricula and its foreseen implementation impacts will be presented. At last, we will show that the chosen approach is green, environment-friendly, and highly aligned with the roadmap of reducing and eliminating paper consumption in academic institutions in the future.

KEYWORDS

Minimum Level of Learning, e-Education, e-Learning, Educational Technologies, Green and Environment-Friendly Teaching

1. INTRODUCTION

India is the most populous country (Demography of India, 2016), approx. 1.21 billion populations, distributed in 36 states and union territories. 40% of the population, i.e. approx. 480 million (more than 80 times population of Finland) are under the age of 19. The age structure demographics of India also illustrate that 31.2% of the population lies in between 0 to 14 years age group (Demography of India, 2016). The government of India has put a stronger emphasis on School-Level education. The Digital-India initiatives, recently launched by Prime Minister of India, has been foreseen to facilitate several e-services including e-Education improving the current digital literacy. Schools in India are continuously updating their course curriculum for digital literacy to keep up with accelerating technological developments. There is a national organization that plays a key role in developing policies and programs, called the National Council for Educational Research and Training (NCERT, 2016) that prepares a national curriculum framework. Each state and the union territory have its counterpart called the State Council for Educational Research and Training (SCERT). These are the bodies that essentially propose educational strategies, curricula, pedagogical schemes and evaluation methodologies to the states' departments of education. The SCERTs generally follow guidelines established by the NCERT, however, the states have considerable freedom in implementing the education system. Education in India is provided by the public sector as well as the private sector, with control and funding coming from three levels: central, state, and local. Under various articles of the Indian Constitution, free and compulsory education is provided as a fundamental right to children between the ages of 6 and 14. The economy of India is progressively growing, and national policy is to build a `Digital India' within all the sectors (particularly Health and Education) of development.

In recent years, the impression of Finnish education system particularly in elementary-level has been highly appreciated by Indian media (*Ramrajya*, 2015). Moreover, a memorandum of understanding (MoU) between the consortium of Finnish higher education institutions and Indian Institutes of Technology

(*IIT_FinnishConsortiumMoU*, 2016) was signed during October 2014 for promoting mutual cooperation. Tot and Zivkovic (2011) proposed that with the advent of modern computer and communication technology, many computer-assisted educational tools have been developed and proliferated excessively in recent years in both the countries. Digital technologies are being incorporated in exciting and promising ways at all levels of education. E-Teaching, e-Content, e-Exam and e-Learning are now becoming the new trends for technology driven education systems. The research results by Kraidy, (2002) show that the current and next generation students are more likely to employ a digital media in their studies. To consolidate progress and to ensure scale and sustainability, educational institutions need to review their organizational strategies, in order to enhance their capacity for innovation and to exploit the full potential of digital technologies and the content.

The Department of Information Technology, University of Turku has developed an e-Education platform. The goal of this development is to realize and implement digitally the course curriculum effectively and efficiently and to strengthen current teaching and learning practices. In this study, we will demonstrate that the *ViLLE* platform that our department has created can be nicely utilized in the Indian school level education system for better learning outcomes.

Various literature (*Ketamo* 2002, *et al* Silius 2014, *Soni* 2010, and *et al* Dattatraya 2015) can be found on the Finnish and Indian education systems independently, but a close comparative study of both the education systems and e-Education platforms currently being employed in each of the countries are still being a subject of research. In this paper, we begin a preliminary study for building an e-Education platform for better learning outcomes in the Indian schools using Finnish educational technology. The paper is structured as follows. The next two sections provide an overview of the education systems of Finland and India respectively. Section IV illustrates a comparative study on *Indo-Finnish education systems*. *Anticipated Implementation Impacts* and *Live Statistics of Students' Submissions* are respectively described in sections V and VI. The concept of *Green and Environmentally Friendly Education* will be discussed in section VII. Conclusion, Acknowledgment, and the References are the subsequent sections of the paper.

2. OVERVIEW OF EDUCATION SYSTEM IN FINLAND

In the reports published in online MBC times (MBC Times, 2015) and fairepoters.net (Fair Reporters, 2015) during the year 2015 clearly, depicts that Finland has been classed in the top five successful countries in offering education to their citizens. According to MBC times report, in 2012, Finland was the world champion for providing the best education. A central objective of the education in Finland is to provide all the citizens with equal opportunities. One of the basic principles of Finnish education is that all people must have equal access to high-quality education and training. The same opportunities to education should be available to all citizens irrespective of their ethnic origin, age, wealth or where they live. Some of the features of Finnish education system (*Education in Finland*, 2012) are listed in bullet points as follows.

- Every pupil and student have the right to educational support.
- Special needs education is generally provided in conjunction with mainstream education.
- Educational autonomy is high at all levels.
- Quality assurance is based on steering instead of controlling.
- Assessment is part of daily schoolwork.
- Teachers are recognized as keys to quality in education.

The primary-level school education in Finland begins when a child becomes 7 years old. A child below the age of 7 years normally goes to pre-school (In Finnish: *Päiväkoti*) where kids mostly learn during playing and indoor-outdoor activities. The details on Finnish secondary, higher secondary and university-level education can be studied online (*Education in Finland*, 2012).

3. INDIAN EDUCATION SYSTEM

The report entitled as *Learning Indicators and Learning Outcomes at the Elementary Stage* (*NCERT*, 2014) published by NCERT in the year 2014 emphasizes that *Access, Equity, Quality, Governance* are the four core priorities of education policies in the Indian elementary level school curricula. The present curriculum is not only prioritizing these four areas but also putting a great emphasis on improving learning outcomes at all levels. Various educational surveys, collected data over the years indicate that learning achievements of children in different subjects at the elementary stage such as languages, mathematics, science and social sciences are not up to the expected level. The reports (*NCERT*, 2014) of joint review mission for SSA (*Sarva Shiksha Abhiyan*- in Hindi) of last few years also mentioned that the learning levels of children are not up to the desirable level in spite of all the efforts made by the states such as timely availability of textbooks and other learning materials, training of teachers and teachers' support material, regular monitoring, and so on. The reasons behind the poor level of learning and not to achieve the expected level are not scopes of this paper. Instead, this requires an extensive research for the educational board of India. However, we emphasize here the use of electronic media, effective teaching tools, and up-to-date online course management system must enhance the learning levels of the children.

4. COMPARISON OF INDO-FINNISH EDUCATION SYSTEMS

The comparison of Indo-Finnish education systems is shown in Fig. 1. Six primary attributes- *education policy, keywords, fees, education objectives, structure and electronic media* are compared to both the education systems. High-quality education is the priority in the Finnish policy level whereas national progress, and national integrity is the preferences in the Indian education policy. Governance versus internationalization are the contrast keywords for Indo-Finnish education system respectively, which clearly depicts that India favors the good governance while Finland emphasizes on making the education more internationalized. There is no tuition fee at any level of the Finnish education system, but on the other hand, India has a hybrid system of tuition fees. The hybrid system implies that the tuition fee is not applicable at the elementary and secondary level in public schools, whereas, at higher educational attainment, at least the tuition fee is obligatory.

	Finnish Education System	*Indian Education System*
Education Policy	Providing equal opportunities for all citizens to high-quality education and training	Aiming to promote national progress, a sense of common citizenship and culture, and to strengthen national integration
Keywords	Quality, Efficiency, Equity and Internationalization	Access, Equity, Quality and Governance
Fees	Education is free at all levels.	In public schools, the education is almost free-of-cost while at private schools, there is a fee.
Basic Education Objectives	The objective of basic education is to support pupils' growth towards humanity and ethically responsible membership of society and to provide them with the knowledge and skills needed in life.	Education liberates human beings from the shackles of ignorance, privation and misery. It must also lead to a non-violent and non-exploitative social system.
Common Structure of Education	***9+3+3***, Six years of primary school (Gr. 1 to 6), three years of secondary (Gr. 7 to 9), 3 years of higher seconday and 3 years of univesity education	***10+2+3***, Five years of primary school (Gr. 1 to 5), three years of upper primary (Gr. 6 to 8), 2 years of seconday (Gr. 9 and 10) and 2 years of higher secondary and 3 years of univesity education
Use of Electronic Media till secondary Education	Usually, all schools employ electronic media such as smart boards, projectors, computers, iPad, internet access, and Television.	Average public schools still employ paper and pencil, though many private schools employ electronic media, however, the trend of using digital gadgets rapidly increasing.

Figure 1. Comparison of Finnish and Indian Education Systems, (Source: Some of the texts extracted from Documents on Finnish National Board of Education, Finland and National Council of Educational Research and Training, India)

5. ANTICIPATED IMPLEMENTATION IMPACTS

The Department of Information Technology, University of Turku has built *ViLLE*-Education collaborative tool for innovative and efficient teaching and learning for elementary-to-higher-level study. This tool enables instructors easily to create courses, their contents and automatically/manually graded assessed exercises of different types. All designed course materials such as activities, tutorials, and the teaching resources can be utilized, commented and evaluated by other teachers as well. Moreover, the platform automatically gathers data about students' learning behavior and creates statistics of the results automatically. This is an ongoing project at our department. Some of the features of the platform include course rounds management, student registration facility, and assignment management, adding and removing exercises, automatic and manual grading system, and student performance monitoring and course statistics. The features of this platform and foreseen learning impacts especially for elementary and secondary level students -are described briefly in the subsequent
sub-sections.

5.1 State-of-the-art e-Learning Methods

Wilma is a popular tool for pre-school and primary schools in Finland. *Wilma* is capable of supporting coordination among children, parents, and the teachers. *Moodle* is another most popular e-Learning tools currently being used in Finnish higher secondary-level schools, polytechnics, and universities. *Moodle* stands for Modular Object-Oriented Dynamic Learning Environment. For online collaboration and the repository of study courses and materials, this tool works fantastically. As this is an open source e-Learning tool, many educational institutions have been employing it. Online web surfing can find more detailed information about Moodle. In the higher-level studies, most Finnish universities have developed their own e-Education tool, for example, Helsinki University utilizes their own e-Education tool, known as *GreenGoblin*.

At the Department of Information Technology, we are developing *ViLLE* e-Education platform. This platform is fundamentally based on the exercises submitted by the students, and this makes it distinct from other learning environments such as *Moodle* and the *GreenGoblin*. Most of the exercises are automatically assessed and they provide immediate feedback when submitted. The same exercises can be used in lectures, homework, and exams in a randomized fashion, however, in the exam mode, the feedback is disabled by default. For undergraduate university level education in IT, the exercises are divided into three broad categories: coding and computer science exercises, mathematical exercises, and general exercises. All exercises created by the editors are automatically shared with all other teachers registered into the system. Private materials can also be attached to courses, rounds, and assignments. In addition to automatically assessed exercises, it supports a variety of manually graded assignments and automated tasks, such as attendances, demonstrations, file submission, study journals and course assignments. Assignments assessed by the teacher (such as essays and class projects) can also be peer-reviewed by other students or colleagues. The details of the developed e-Learning platform are available online at villeteam.fi/en (*ViLLE Team Research* 2016).

5.2 Foreseen Impacts on Elementary-Level Students

The learning impacts are listed as below:

- The current edition of *ViLLE* platform includes several exercise sets for elementary-level courses and secondary-level courses. The exercise sets for elementary-level such as *recognizing number, number sorting, match pairs, number line and the drilling games* not only facilitate learning but also enhance the aptitude of a child. The children learn many things in a short period of time without thinking (by rote) more during his/her study.
- The chosen learning approach is such that children assume as if they are carrying out some kind of fun during their study. This does not put any stress on the children mind

- The easy-to-hard exercises such as *calculate in a row*, *expression exercise* and *calculating with whole numbers* in a mathematics course for grade 1 to grade 5 enable the children to grasp and understand required basic concepts in a very handy approach.
- The *ViLLE*-based teaching methodology will certainly give sufficient scopes for creative thinking instead of rote learning. The Indian national survey also reveals that rote learning is an evil education system (*Ramyal,* 2016) that does not meet the overall performance benchmark.

5.3 How *ViLLE*-Platform Enhances the Learning Outcomes?

The approach and methods that *ViLLE* platform is using for enhancing the learning outcomes are listed below.

- We have conducted an experiment *et al* Kurvinrn, where automatic assessment and immediate feedback was utilized to support the learning of mathematical concepts for first-grade students. After analyzing the result outcomes, we noticed that automatic assessment and visualization had a clear positive impact on the learning performances of the pupil.
- Likewise, we had performed another experiment using *ViLLE* platform *et al* Lokkila, where a threshold value indicating the corresponding skill level for each of the students was assigned. This threshold value provided by the platform gives the teachers an additional method for identifying the students who have not yet fully understood a topic and need further instruction.
- The *ViLLE* platform utilizes child-centric-approach for ensuring the minimum level of learning and to achieve the desired competence.
- The exercises at *ViLLE* Platform are enriched with the requirement of curriculum's basic objectives, and the load to a child is very limited. Hence, the children do not face any difficulty in learning Mathematics and other related courses.
- Finnish education system usually obeys activity based teaching and joyful learning strategy. The practice exercises built on the *ViLLE* platform are highly aligned with such teaching strategies.
- The course contents built on the *ViLLE* platform are standard enough irrespective of the course textbooks or the reference books employed and also regardless of professional competencies of the appointed teachers.

5.4 Live Statistics of Students' Submissions

Enhancing learning capability of a child is very crucial, and the learning outcome is directly proportional to the submissions into the e-Education platform. The feature like *live statistics of students' submissions* will be very advantageous particularly in the Indian context as this would visualize a pattern for average daily, weekly, monthly progress of the submissions, and moreover, these visual diagrams can be monitored remotely from a server room or from the control room. The visualization is something similar to 24 by 7 stock market data or environment monitoring system. Several manipulations can be performed on the server side to see the progress of a particular campus or a school's submissions. This feature will help a higher authority to monitor not only the submissions by the students but also identifying lack-of-submissions zone and the teacher's effort. A sample snapshot of live statistics taken on 19th May 2016 is shown in the Fig. 2. The dark blue color of bar chart represents the present submission while light blue symbolizes the past submissions. For example, in the upper left corner, the dark and light blue bars respectively denote today's and yesterday's submissions.

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Figure 2. Live Statistics of Students' Submissions using *ViLLE* Platform

6. GREEN AND ENVIRONMENTALLY FRIENDLY EDUCATION

The recent trends show that the use of computers is genuinely replacing the paper-based operations in day-to-day life. The education system is also not untouched with this phenomenon. The modern computer-assisted educational system is becoming more sustainable and environmentally friendly, and this practice is progressively advancing as the time elapses forward. Paper consumption is one of the most direct and visible impacts to the environment caused by universities and academic institutions. Research (*Reducing and Eliminating Paper Consumption*, 2010) shows that one ton of A4 paper is equivalent to 3.47 ton of wood, which is equivalent to 24.29 trees. The number of paper consumption reduction and elimination initiatives in educational institutions is growing very rapidly. With the *ViLLE* platform, we have been using a paperless transparent and effective examination and evaluation system for the students. As an experimental data, we have saved 47 × 6 A4 size papers in a single examination. If one thousand students from all over Finland would use *ViLLE based* system in education, they could save 282000 pieces of A4 paper in average for one course. If we consider ten courses per year per student, then 2.82 million A4 sheets will be saved, drastically lowering the environmental impact. In a similar way, other resources such as energy and materials consumed to produce such an enormous amount of paper will be saved and the environmental impact in production, processing, transportation and disposal can be neglected.

7. CONCLUSION

Based on the above facts, we conclude that there is a necessity to implement an e-Education platform at Indian school-level courses for achieving expected level of learning among the children. After the implementation, at one side, the learning outcomes of the children will be increased while at the other side, managing the courses contents, teaching and evaluation will be much easier. The approach is green and environment-friendly. Hence the teaching and the learning using e-Education platform will be highly beneficial for the country like India.

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AUTOMATED ASSESSMENT IN MASSIVE OPEN ONLINE COURSES

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ABSTRACT

This paper describes an approach to use automated assessments in online courses. Open edX platform is used as the online courses platform. The new assessment type uses Scilab as learning and solution validation tool. This approach allows to use automated individual variant generation and automated solution checks without involving the course author. The approach implementation is based in XBlock SDK provided by Open edX developers team.

KEYWORDS

MOOC, programming assignments, Scilab, automated assessment

1. INTRODUCTION

Nowadays Massive Open Online Courses (MOOCs) are trending in both e-learning and traditional learning. One of the most popular open education platforms is edX. In June, 2013 the platform's source code was released on Github and everyone willing got an opportunity to deploy his own edX platform instance and create courses there. The open-source version of the platform was named Open edX, indicating being open software.

Typical MOOC consists of video lectures, quizzes, tests and discussion boards. The test items can be represented by various types, for example, text input, drag-n-drop, sequence problems, and virtual laboratories with automatic check. Also some MOOC-providers support more complex problems types, where student should give an answer by uploading an artifact, such as essay, picture, etc. Student should accomplish an assignment following to instructions given by course author and upload the outcome to the system.

Some assignment types are difficult to assess such as programming task or modeling problems. Generally, assessments that check modeling skills are assessed by experts (usually, teachers or assistants), but including those types of problems in massive online courses causes some issues regarding number of students. Since number of students grows, such types of assessments become more difficult to check due to the number of solutions uploaded. It becomes even worse when each student is assigned a randomly parametrized problem, though these type of problems can be graded using determined instructions in an automatic mode.

Scilab is an open source, cross-platform numerical computational package and a high-level and numerically oriented programming language. This package can be used to assess student skill to perform mathematical modeling or skill to perform computing of any kind, for example to calculate matrices parameters. Common assignment types, which can use Scilab packages as a validation tool, are mathematical or physics problems including process modeling, programming problems that use Scilab programming language for modeling purposes.

This paper proposes an approach to assess such assignments using Scilab as student learning tool and student solution verification tool. The main aim of the approach is to provide individual and random parametrization for problems.

2. MASSIVE OPEN ONLINE COURSES PLATFORM

Open edX is a popular platform that provides possibility to hold massive open online courses. Numerous instances are deployed all over the world and its number grows everyday.

Its main components are learning management system (LMS) and content management system (Studio, earlier – CMS). LMS provides the learners (the students) with access to learning materials, such as video lecture, assessments and forums. Students can pass assessments and earn grades depending on their success using this system.

CMS is a system where course author can create courses, configuring its outline and the course structure in general. Authors can also add video lectures using special UI components, configure the due dates of assessment submissions and so on.

Open edX platform support different assessment types. Such assessment types as text input, image input, code input, sequence input, drag-and-drop input are provided. The number of them is continuously growing, and it is possible to extend the quantity of supported components using an application programming interface named XBlock. This interface was created by the Open edX developer team to extend support of custom components which are not supported out-of-the-box. The most common use of this interface is interconnection of different services. Many corporate systems have been created and have collected much data that can be re-used. By now many systems have already developed different solutions to support behavioristic assessments, which are not supported by Open edX, but using XBlock interface makes it possible.

There is no support of Scilab-assessments with source code in Scilab programming languages required as student submission implemented by Open edX team, so it may be implemented via XBlock API.

Usually, when saying the edx-platform combination of CMS and LMS is meant, but there are much more components in there. One of them is XQueue. XQueue is a component which provides messaging services. Messages are text strings in special format. The format of messages is defined by its users: consumer and producer. In this paper producer is LMS and consumer is Scilab-server. The idea behind the queue is that all the requests are performed asynchronously with the first-in-first-out principle. It also makes possible to enqueue such operations as variant generation and submission check, and close browser pages from which those actions were requested, as they still will be performed when the server is ready.

3. WORKFLOW SCENARIOS

General scenario may be described from two points of view: student's point and course author (instructor) point.

The overall idea that stands behind the process is that the system automatically validates user submissions written in Scilab programming languages. To make it work some restrictions are to be given.

By design each student should receive individual task variant. This is possible when some rules of generation process are provided. Describing the variant generation process is fully up to the course author. To make the workflow easier the generation script is supposed to be written in Scilab programming language thus making generation process and executing student code quite similar.

If no variant has been generated yet, the student receives personal unique variant. So viewing the same problem again and again will not generate more variants for particular student, but still, each student will have his own variant data. This is possible by storing variant data associated with particular student viewing the task. This will also allow the student to leave the page with current task and return to it later, even using another computer.

Student is supposed to create some artifact which represents his solution and submit it to the system. It may be source code written in Scilab language, which may be executed to reproduce some calculations, or models created by student and which are to be validated. Student has limited number of attempts and earns highest grade of all his submissions' grades.

As the student has his solution submitted he is waits until his solution is checked and validated. When the check is performed, he can see his final grade.

Course author, at his turn, provides data and configure module for students. The two most important aspects are task text, which is shown to students, and check instructions. Course author may also provide instructions to generate an individual variant for each student, though this feature is optional. Author can configure the module via special user interface. See table 1 for problem parameters.

Table 1. Problem parameters required to configure module

Parameter	Explanation
Display name	Each task should have a caption which will be used in statistical reports or other UI-elements
Queue name	The component uses XQueue as message broker, this parameter holds the identifier to the queue where all messages are stored
Attempts	The number of attempts allowed to submit solution
Weight	Weight of the task's grade
Instructor archive	File containing generation and check scenarios; a check scenario is mandatory and a generate scenario is optional; in case when the generate scenario is absent no variant generation is performed
Task text	Text showed to student when he opens the task page; it may contain substitution symbols to be templated with random parameters generated by generate script

The system requires special instructor file to be uploaded. This file is simple zip-archive which contains generation and check instructions. As the variant generation is optional, this archive may contain no generation instructions, so the module will not generate random data for students. Thus this module will not communicate with other subsystems to generate a variant, though check scenario is required anyway. Both check and generate scenarios are written in Scilab programming language to simplify the process.

4. IMPLEMENTATION

This paper describes an approach, where Scilab tool is used for assessments in online courses. While attending an online course on modeling basics, students are supposed to come through special assessments besides basic quizzes and tests. Students are to obtain personal task which is randomly generated for each attendee and later fulfill task providing their own solution using Scilab package. The solution may be represented by source code written in Scilab programming language or by a model made in XCos environment, part of Scilab package.

Latter the solution is checked by a special service called Scilab server, using rules provided by the course author. Scilab server is a special environment developed to handle Scilab-based assessments. This environment is an HTTP server that uses XQueue servers as message broker and performs execution of checking scripts.

Scilab server may be used for generating variants or checking solutions. To make server perform any action the message is required to be sent via a message broker. This message contains details on action to be performed with all supplementary details. For example, student script and checking instructions are necessary to assess the solution, and for generating individual variant generating instructions are needed. The message is string in json-format, which is passed via HTTP-request body. A javascript object encoded in this string should contain particular fields, for example, a field describing a method to execute, as “generate” or “check”, and submission identifier.

Scilab-server does not have ant pre-loaded instructions to generate a unique variant or check a users solution. This make the server independent from the course author. When the server receives a message to check or generate, it also receives instruction to perform action requested, so for generation it retrieves generation instructions right in the message, for check it receives student solution along with checking instructions provided by course author. Such implementation makes the server versatile, thus it can be used in different courses no matter of assessment types and aims.

There are two types of messages implemented in Scilab server for now: a message to generate an individual variant or a message to check user solution.

4.1 Unique Variant Generation

The generate-message contains data required to generate an individual variant. When generate-message is received by Scilab server, it launches a generate process which is illustrated in figure 1.

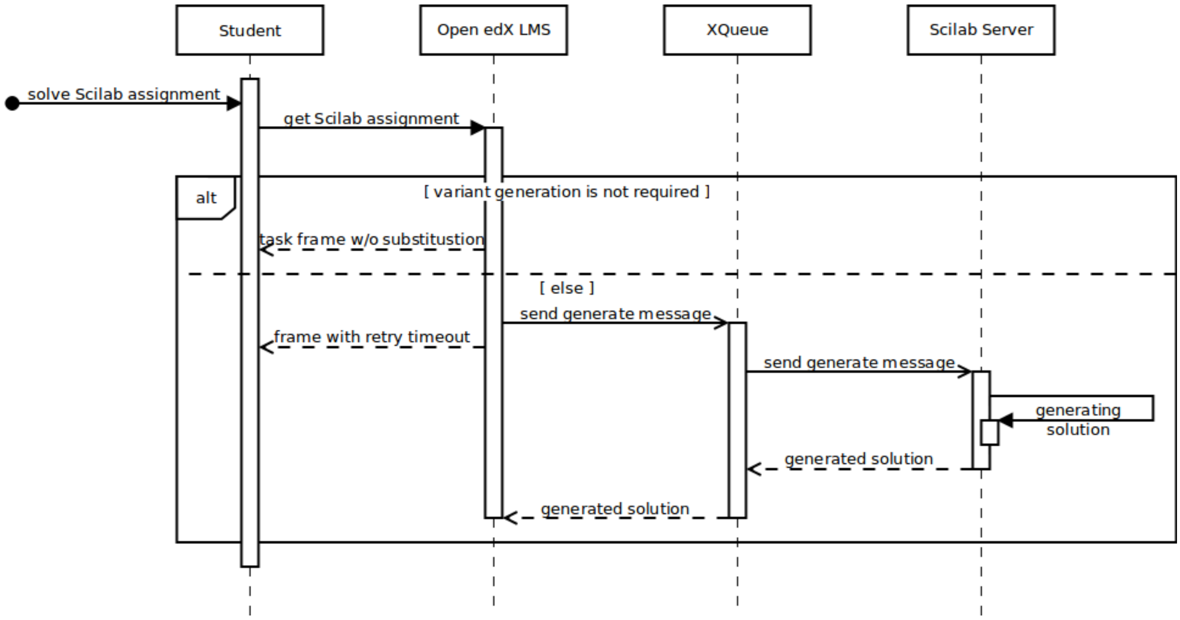

Figure 1. Unique variant generation sequence scheme

When the student opens a problem in LMS, the system decides whether the problem need a random variant to be generated or not. If not, the problem text is displayed as it-is without any template substitution routines. Otherwise the system generates a new variant for the student if no variant was generated before. Then the LMS system creates generate-message, which is sent to Scilab-server via XQueue.

First, the server extracts the contents of the instructions archive in a temporary directory on the server as the message is received. Then the Scilab server executes the generation scenario from the archive. The scenario name is always the same for any task. This scenario is provided by the course author and should produce an artifact: a text file with a variant data. This file is later used to display task data in LMS and to check a user solution. The generation itself is optional, so the Scilab server may never receive this type of message for specific tasks.

The generation artifact is a simple text file. It may contain several text lines. Each line represent a single parameter of the variant. For example, it may be random coefficients to solve an equation. The system does not care about the number of parameters, as it is an agreement between the generation script and the checking script. This text file will be passed as-is to the check script later. Also all the parameters listed in this file will be shown to the student in the problem text with the rules described below.

As the random variant is generated it is sent back to LMS with XQueue as a broker.

4.2 Problem Text Display

The problem text is a crucial element of a problem as it describes the guidelines to follow while solving the task. It is always up to the course author to give instructions which are comprehensible to students.

As far as the kind of problems proposed support parametrization with unique personal variant variables, the task text should support parametrization too. Thus a simple templating system is implemented.

The variant generation should produce a text file. It may contain any number of text lines where each line represent a single parameter. So, if the generate script creates a text file containing two lines, the subsystem decides that the random variant has two parameters.

When a student should sees a problem text, the subsystem substitutes all special character sequences "%s" with generated parameters. To be more precise, the first occurrence of "%s" in problem text will be substituted with first line of the pregenerated file, the second occurrence of “%s” will be substituted with the second line of the file, etc.

To avoid conflicts, in case when there were some errors with comparability, for example, when the task text was unintentionally changed or a wrong generation script was uploaded earlier, no substitution will be performed if the number of substitution symbols and the number of generated parameters do not match.

4.3 Student Solution Check

The check process is similar to the generation process but still has some differences. It is also initiated by the message received from a message broker, but has a different type descriptor. The message contains a check scenario that should determine a grade for a student solution. The check scenario is a Scilab script which uses unique variant data and a user solution. Though the generation is optional, the check scenario may use the student solution only. The whole check process is illustrated in figure 2.

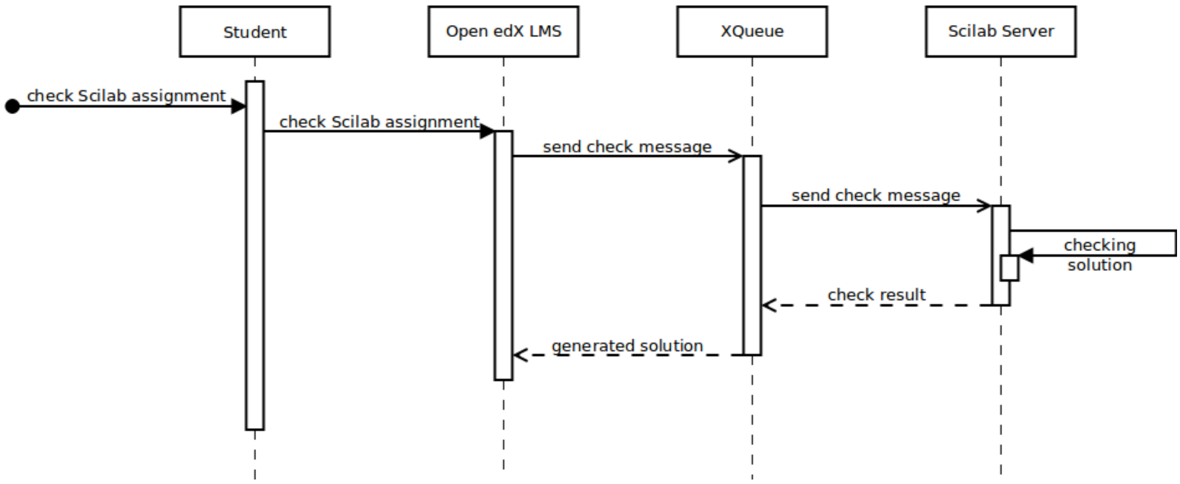

Figure 2. Solution check sequence scheme

When the student uploads his solutions, the checking process starts. LMS creates a message containing data describing type of the message and student solution to be assessed. This message is sent to the XQueue server and later to the Scilab-server.

When the check message is received the server extracts a user solution to temporary directory. If the student solution contains any executable Scilab script, it is executed, though the student solution may contain no scripts at all. That may happen when the task outcome is model created with XCos, then no user script is executed. After that Scilab server creates a file with pregenerated data, if this task needed generation, otherwise this step is skipped. Finally the check scenario is executed. It is written by the course author so it may optionally use pregenerated unique variant data and must validate the user submission. A grade allowed is a real number between 0 and 1.

As the server generates the answer message containing students grade and some additional data, for example, a feedback message, it is sent back to LMS via XQueue, in the reverse way as it was received.

4.4 Examples

For example, there is a task requiring a student to solve a linear equation ax+b=0. Each student is provided by randomly generated coefficients a and b. The task is to submit a file containing source code written in Scilab programming language that calculates variable x within specific precision and outputs this value into a file.

Generation instructions are shown below.

```
// Generation instructions
// Initialize random generator
seed = getdate("s");
rand("seed", seed);
// Generate individual variant
a = rand() * 2 - 1;
b = rand() * 2 - 1;
// Save variant
fd = mopen("./generate_result", "w");
mfprintf(fd, "%f\n%f", a, b);
mclose(fd);
```

The generation script randomly generates real numbers for a and b between -1 and 1 and outputs them into a file. The file created is latter used as variant data in the checking scenario or in LMS to display the task text to student.

A sample of the task text is shown below.

```
<p>Solve an equation [mathjaxinline]ax+b=0[/mathjaxinline], where:
[mathjaxinline]a = %s[/mathjaxinline], [mathjaxinline]b =
%s[/mathjaxinline]</p>
<p>Submit a <i>*.zip</i>-archive as an answer. It should contain file
<i>solution.sce</i> with Scilab source code. This script should create
file <i>output</i> in working directory. The file should contain saved
variable [mathjaxinline]x[/mathjaxinline].</p>
<p>To save data from Scilab script use <i>save</i> function.</p>
```

The task text contains substitution symbols %s which are replaced one by one using pregenerated variant data. There are two substitution parameters, so there are two parameters required to be generated with the generator script.

Check instructions are shown below.

```
// Check instructions
// Read data from individual variant
f = mopen('./generate_result);
[n, a, b] = mfscanf(f, "%f\n%f");
mclose(f);
// Load data generated by user solution
load('./output', 'x');
// Grade user solution
score = 0;
eps = 1e-5;
// Set full grade if user solution performed calculations
// within precision required
if abs(a * x + b) < eps
  score = 1;
end
// Save student score
write('./check_output', string(score))
```

The check scenario first reads pregenerated data provided by the generate scenario. There must be exactly two parameters, and we are sure that the file contains both of them. This file was previously generated by the generate script and it is created along with the check script as-is.

Then the check scenario reads the user output. The user scenario was executed earlier and it should have created output a file as the task text requires. The check script reads the value and compares it with the correct one. If the user's answer lies within given precision, the answer is treated as the correct one, and the student is awarded with the highest grade possible.

5. CONCLUSION

This paper describes an approach and implementation of automated assignments, which allow to check students' skill to perform calculation and modeling using Scilab computational package. The module developed was deployed to one of edX instance and is now successfully used in online courses.

This approach was used in two courses on National Platform of Open Education, the MOOC platform co-founded by 8 Russian universities. The courses are “Elements of control systems” and “Linear control systems”. Both use the developed module to assess students' learning results.

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APPLICATION OF DIGITAL CYBERSECURITY APPROACHES TO UNIVERSITY MANAGEMENT – VFU SMART STUDENT

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ABSTRACT

This paper suggests digital approaches in university management. Digital transformation requires leadership that can maintain and balance competing interests from faculty, administrators, students and others. The team of Varna Free University designed a flexible proper solution VFU SMART STUDENT aiming at lower operating costs and better performance is application of cloud technologies. It is a web-based information system for provision of e-services to VFU students, which provides comprehensive information about the student from their enrolment until their graduation. Network monitoring system is used to make the transition easier, and to improve network effectiveness. Security policy, procedures and guidelines are adopted to guarantee seamless operating of networks and systems.

KEYWORDS

e-management, cybersecurity, network, servers, digitalization, university

1. INTRODUCTION

In the last few years, technology underpins everything in higher education, administration, academics and IT. The IoT is about every connection on campus and it can drive improved outcomes—intelligent connections deliver efficient operations and improve safety and security, while video and collaboration provide better teaching and learning (Kylie Lacey, 2016). Universities need to accelerate the integration of technology into the institute, enabling students to harness technology in ways that give them more flexibility and increase efficiency. This is an absolute must as students expect to have access to the best tools for collaboration and execution. Technology has changed the face of how this generation called Millennials interact with brands and this is true of universities as well. Digitalization of student services, library facilities and administrative assistance will not only help the institute simplify processes but also help students engage with their university in a more familiar setting.

“There is an urgent and immediate need for educational institutes to start speaking the same language as their students – The digital tongue” (Michelle Melbourne, 2015).

The knowledge based society of the 21st century turns production and knowledge management (KM) into a sector of primary importance. The great potential for synergy between knowledge management and the intelligent approaches to university management seems obvious given the numerous interrelations and dependences in these two areas. The relation between them, however, is not completely understood and mastered. Currently, the e-learning technology is mainly used for preparing teaching courses in topics chosen according to the educational needs. The knowledge management technology is applied for quick mastering, organization and provision of significant quantities of corporate knowledge.

Some authors consider the integration of e-management and knowledge management technologies in order to improve the mastering, organization and provision of significant quantities of corporate knowledge (Miklos and Bence, 2015). In this study, an attempt is made to create a new framework of how universities work and characterize „fourth generation” universities. Nowadays the effective development and advancement of universities is unimaginable, the knowledge management activities need to be integral part of these institutions in everyday life. Student e-services management using e-governance is success story in many universities (Rahul Kulkarni, 2015). The main objectives are saving on cost, time and efforts of university administration. A project called 'e-Suvidha' for university students is a model for universities in the world. To achieve the world class standard it is necessary to have an improved collaboration and access to information available in all the parts of the world which is possible only by introducing e-governance (Raizada, Saxena and Shrivastava, 2014).

Another point of view states that the success of the e-governance at universities is not only determined by technology but also by the consequences and acceptability by the society in general and stakeholders in particular. Universities image in the society has levitated high and these initiatives taken have played a vital role in university achieving the highest grade accreditation (Er. Maroof Naieem Qadri, 2014)

Many probable benefits from the e-services are reported: for service users in terms of reduced cost of transmitting information and resources accesses, lesser time and cost for services; for service provider, reduced processing time, error rates, complaints; and for government, improved service consistency and equality; and finally, the benefits lead to enhance the outcomes, as well as the performance criteria (Suklabaidya and Sen, 2013).

The main services that can be provided by implementing above type of governance system are connected with the centralized database which provide better opportunities to students and can empower the governing body to plan the development of the education system as a whole (Prateek Bhanti et.al. 2012).

There is much evidence for the benefits from e-governance systems, through improved working operations and lower operational costs. The benefits far outweigh the risks, such as cyber-crime and make it more likely that more institutions will embrace e-governance.

“The only way for a university to grow phenomenally and yet continue to be managed optimally with a clear vision on quality is to embrace e-governance systems immediately,” (Moses Talemwa and Yudaya Nonagonzi, 2016).

2. BACKGROUND

In an era where mobile apps and cloud technology is the norm universities look for ways to implement digital approaches in their management and to deliver more online services to their students, administrative and academic staff. Such a digital transformation requires leadership that can maintain and balance competing interests from faculty, administrators, students and others. Continuous training of ICT skills of all the staff becomes a topic of general importance for higher education institutions (Pfeffer, 2012)

This paper suggests digital approaches in university management. There are good practices for transformation of a small, undistinguished college once criticized as an “admissions bottom-feeder” into a selective university that attracts applicants from around the world” (Leo Lambert, 2016). One of the basic milestones on the way to the success is the campus culture and always be in the process of becoming better and better using the last innovative technologies.

Varna Free University (VFU) is among the first educational institutions in Bulgaria that decided to introduce e-services in order to optimize the university management. The team of the Institute of Technology at VFU set up a project to create a support model for instructors when innovating their training process. The project started with a formulation made by the instructors of the hypotheses concerning the possible added value of an e-management platform.

3. OBSERVATIONS AND DISCUSSIONS

The team of Varna Free University designed a flexible proper solution aiming at lower operating costs and better performance is application of cloud technologies. The IT infrastructure of VFU consists of 36 virtual servers and only 3 physical servers. Network monitoring system is used to make the transition easier, and to improve network effectiveness. Security policy, procedures and guidelines are adopted to guarantee seamless operating of networks and systems. After testing a variety of offerings, we settled on a product that could provide unified IT monitoring and management.

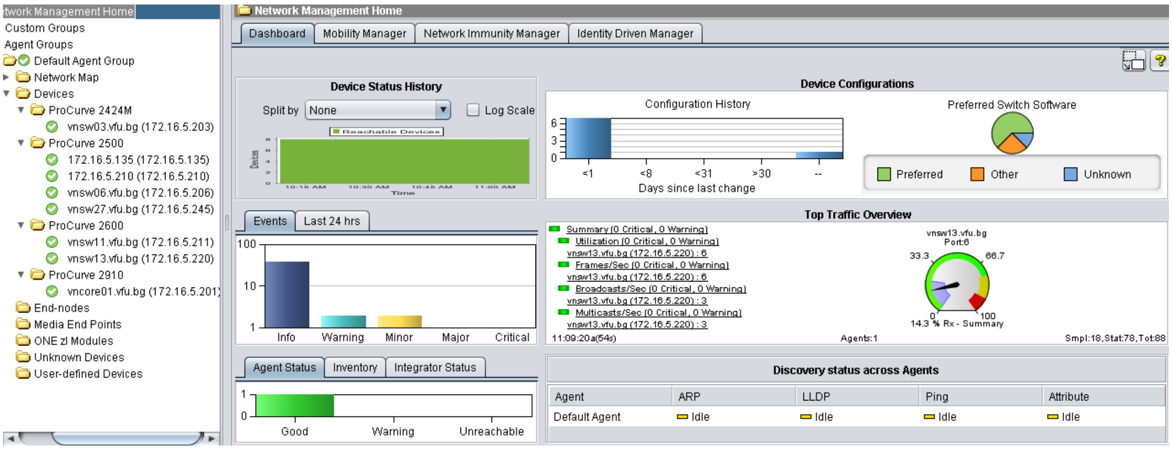

Figure 1. Network monitoring

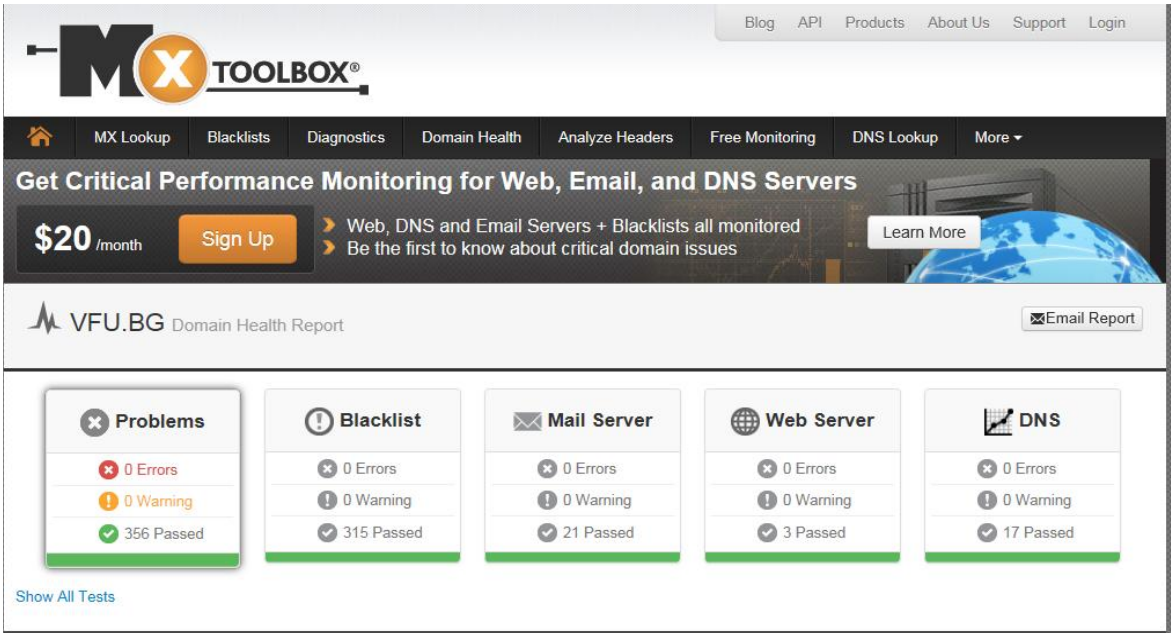

Figure 2. Web instrument for monitoring of vfu.bg

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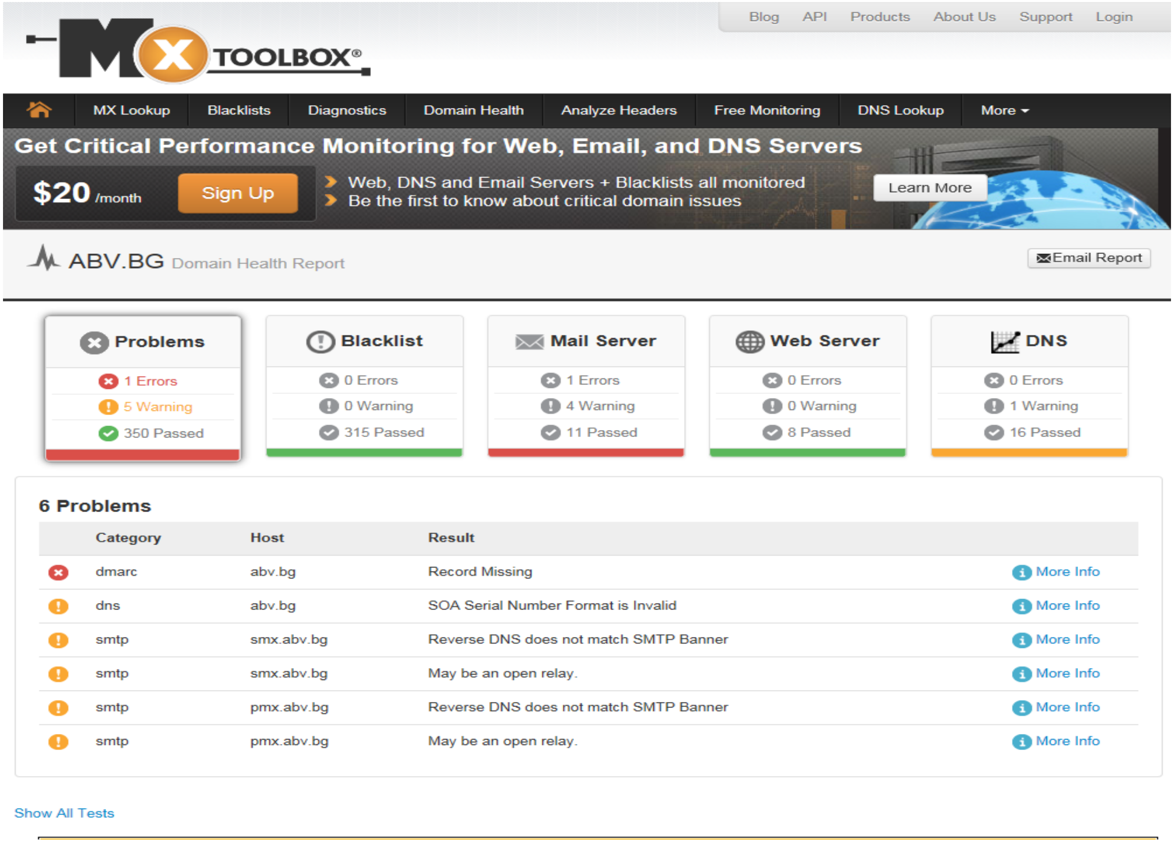

Figure 3. Web instrument for monitoring of abv.bg (comparison)

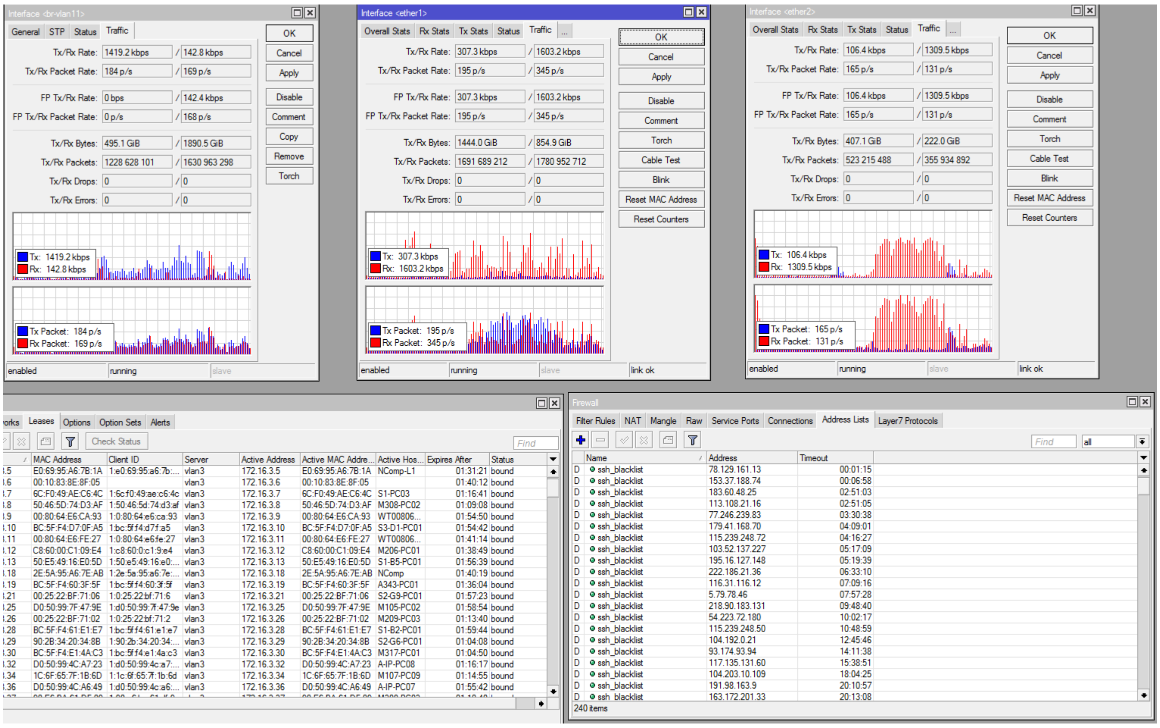

Figure 4. External traffic monitoring system for real-time preventing of attacks

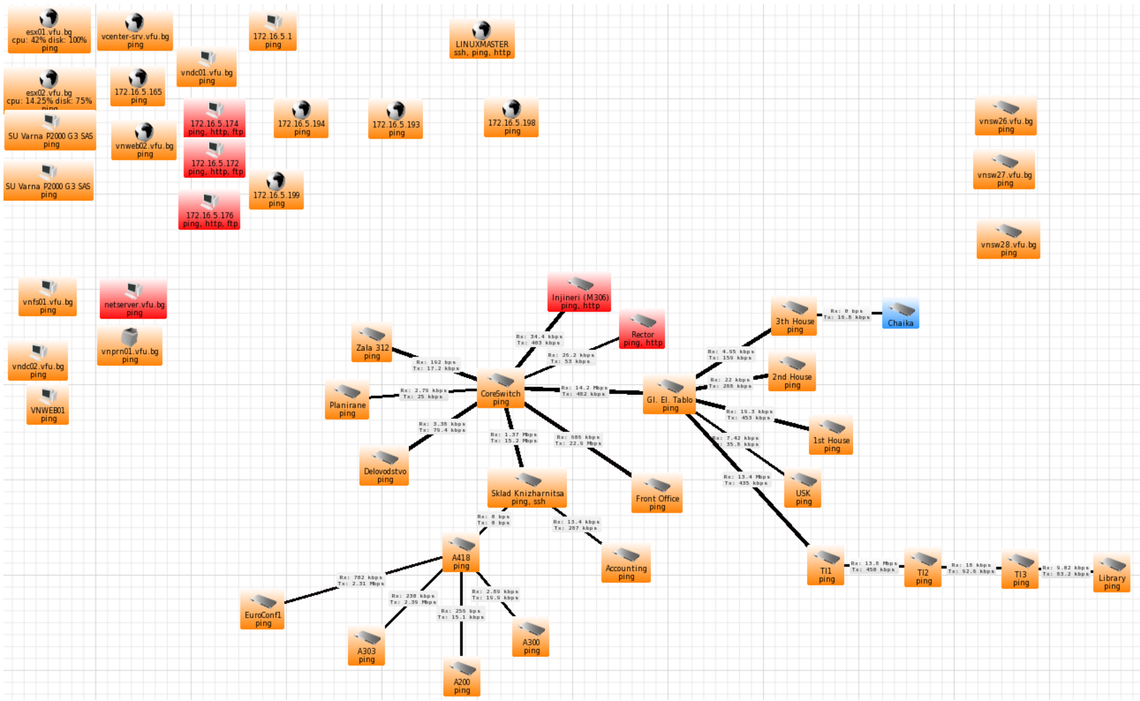

Figure 5. VFU network – physical servers and hubs

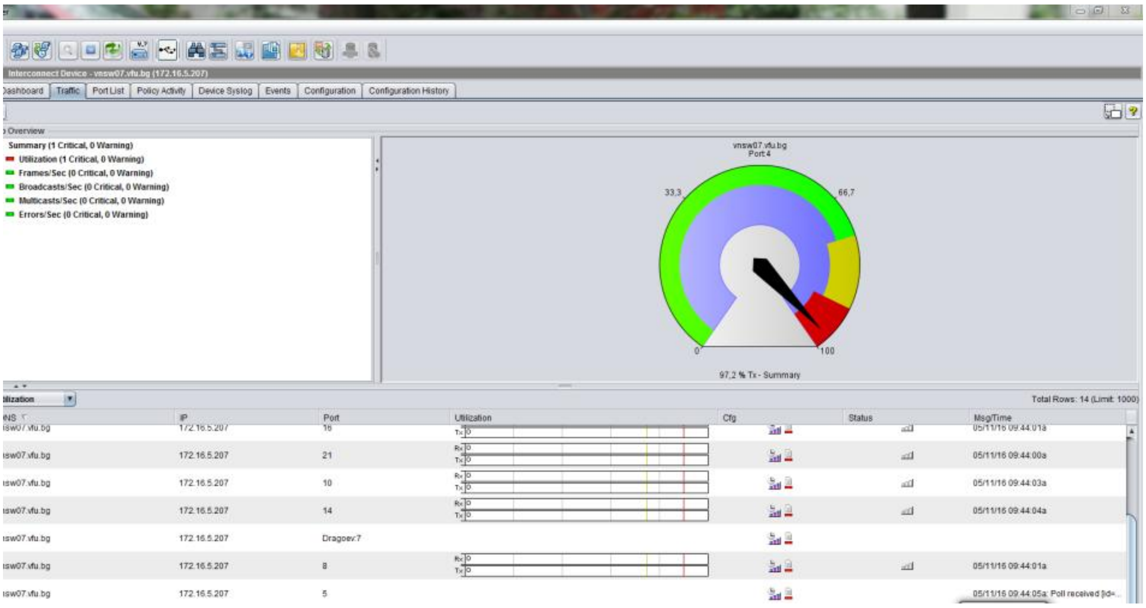

Figure 6. Overloaded port

Moving from "server monitoring" to "service monitoring," don't necessarily care what the server is doing at the high level – just what it's doing for our students, administrative and academic staff. The monitoring system can provide visibility into both cloud and physical resources, to make the transition easier. It is giving alerts of modules that are working intermittently or sporadically, or backend equipment that may not have been cleanly set up, which hampered application performance. With the help of the system the IT staff cleaned up many performance issues, and quickly identified points of poor performance. Cloud scalable servers are used to meet the growing needs for online services.

It is imperative for education providers to digitalize, empower their workforce and make their processes more efficient. An important element of that processes is the digitalization of the core university administration tasks that can be split in to front and back office tasks. Front office admin tasks can be student admission, course change, fees payment plans and student appeal forms while back office admin tasks can be HR contracts for staff, HR performance reviews, etc. Different universities have different applications, closed platforms that hinder data sharing and need specialized IT training to operate but most of them choose open formats like HTML, PDF and XML that allow easily to use legacy systems together to share data.

4. RESULTS

The complete e-provision of e-services to VFU students will be performed through VFU SMART STUDENT system. Its application will help to:

- provide quality administrative e-services at any time, at any place and through alternative access channels;
- optimally use the existing applications in order to increase their stability, reduce the time and means to develop new ones, as well as reduce the maintenance and servicing costs ("E-planning" System);
- achieve complete digitalization of data – step by step transition to entirely digital form of all data in student servicing, as well as to a more active electronic exchange of documents among VFU units;
- implement software solutions with open code in order to solve the license issues in the university;
- introduce in accelerated way cloud technologies for remote access to share resources - Cloud Computing, in order to improve security and reduce costs;
- provide maximum protection of processed and stored data.

4.1 Goals

- improving the quality of offered services;
- providing transparency and accountability;
- achieving maximum effect and sustainable development while optimizing costs and working processes;
- providing information security management and information protection;
- introducing integrated e-servicing environment and single entry point (VFU Hub);
- single collection of data by the administration and its multiple usage to generate various reports;
- gradually moving to paperless turnover of documents, modeling and change of working processes, and orientation towards organizational efficiency;
- introducing priority e-services;
- development and usage of network and information resources.

4.2 Implementation Approach and Types of Services

4.2.1 VFU Hub Smart Student

A major element of the "digital transformation" is adopting technology and applying it to the very core of how various systems work in a university setting. A working example is the application of VFU SMART STUDENT solution at Varna Free University. VFU SMART STUDENT is a web-based information system for provision of e-services to VFU students, which provides comprehensive information about the student from their enrolment until their graduation. The aim of "Smart Student" is to provide quick, suitable, easy, comprehensive and secure provision of services to students by giving them access to VFU information resources.

The advantage is that there is a constant access to data and changes are reflected in real time.

VFU hosts internal support systems from document management systems to e-learning management, which are currently hosted in the cloud. Constant monitoring and maintenance is needed.

5. CONCLUSION

The future of Bulgaria as an emerging destination for international students will largely depend on how well educational institutions in Bulgaria adapt and respond to students' expectations and provide a value proposition as technology and business models evolve. One of the main factors for success is increasing the efficiency and effectiveness of provision of administrative services and achieving maximum effect with minimum resources. Also there is an opportunity for 24/7 working cycle and the realization of e-services provokes quality change in working processes. The proposed solution guarantees information security with the necessary basic infrastructural components for protection of information assets.

6. THE FUTURE

This work-in-progress paper looked at the design of integrating platform web 2.0 tools with the existing LMS to create a "learning 2.0 as a platform. The next steps are to evaluate the design through data collected from multiple sources like student logs, Facebook feeds, focus group, reflections, and student satisfaction data. On the basis of statistics and analysis an optimization will be made in response to changing input from students and the arrival of new technologies.

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DEVELOPING A TECHNOLOGY ENHANCED CS0 COURSE FOR ENGINEERING STUDENTS

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ABSTRACT

The CS0 course in the curriculum typically has the role of introducing students into basic concepts and terminology of computer science. Hence, it is used to form a base on which the subsequent programming courses can build on. However, much of the effort to build better methodologies for courses is spent on introductory programming courses instead of the earlier course. In this article we present an experiment where a CS0 course at our university was redesigned to utilize educational technology and automatic assessment. The redesign was based on a collaborative education platform called ViLLE. New automatically assessed exercise types with immediate feedback were designed and utilized with already existing ones to cover all topics taught in the course. In the paper, we present the design principles and the implementation of the electronic material for the course as well as our experiences on adapting the technology in the course. A detailed description of different exercises and other tasks are also provided. Finally, we present results and statistics collected from the course implementation.

KEYWORDS

Active learning, Course redesign, Automatic assessment

1. INTRODUCTION

In the modern world, the quest for effectiveness has driven educational institutes to reform their teaching curricula. The department of Information Technology at the University of Turku underwent a curriculum reform, in which courses were redesigned to include a more active take on learning. Some courses were refactored heavily, while others only received a slight makeover. Formerly, the introductory courses consisted of a set number of lectures and a final exam, on which the students were graded. The main reason for only a slight makeover was one from the list by Bonwell and Sutherland (1996): limited resources. The introductory courses remained lecture-heavy. However, electronic study materials were introduced to the course, which allowed students to put the theory taught during lectures into practice with little to no additional work load to the teaching staff.

This paper provides results on an application of active learning strategies to an otherwise traditionally lectured course. Student performance data was collected from six instances of the course, from 2009 to 2015. The first three instances were purely lectured. Students considered the course to be very difficult and grade averages were low. Active learning strategies were introduced to the course in 2012 in the form of automatically assessed electronic exercises and lecture questions. Student activity was measured by lecture attendance and scores from the electronic exercises.

2. RELATED WORK

The term “active learning” is used to mean a strategy of teaching, wherein the student is actively taking part in the learning process (Bonwell & Eison, 1991). Instead of passively sitting through a lecture, students interact with the subject matter in some way; either through discussions with one another and the teacher, or read or write about the subject matter in order to learn the content being taught (Candido et al., 2007). Bonwell and Sutherland (1996) propose a conceptual framework for active learning: a continuum from the simple task to the complex task. Neither side is 'better' than the other, instead, the educator must choose which part of the continuum is best suited for the course and students in question and subject matter being taught. The pedagogy behind active learning is heavily constructivist: students, by being immersed and engaged in learning, create meaningful information based on their interaction with the subject matter (Montero-Fleta et al., 2012).

Other course reforms to adopt a more active learning method have met with success. Kaila et al. (2015) reformed a CS1 course by swapping half of the lectures into tutorials, wherein students work in pairs to solve problems. Lecture questions that were meant to activate students were introduced to the remaining lectures. Goodhew and Bullough (2005) adopted a CDIO approach in their refactoring of a materials science and engineering course. They outlined a clear strategy on how active learning is put to use on their course. Steps to increase the engagement of students with the exercises have also been applied. More interactive exercises have been introduced to courses to increase student engagement with the subject matter. For programming courses, Parson's problems (Parsons & Haden, 2006; Lopez et al. 2008; Helminen et al., 2012) have been found to be a useful addition

3. EXERCISES

At the heart of the refactoring are the exercises students were completing during the course. Instead of the traditional method of having students answer exercises on paper, we used the ViLLE learning platform (Laakso et al. 2016) to collect student answers. ViLLE provides students with immediate feedback on their performance in the given exercise. This is realized at the minimum by telling the students whether their answer is right or wrong and showing the correct answer when the given answer was incorrect. More elaborate feedback includes specific steps on how to solve the given problem, for instance, a quadratic equation. The reasoning behind favoring automatic assessment of exercises over manual assessment is to enable students to answer more exercises, and receive individual feedback on each answer immediately after answering.

ViLLE provides teachers with a multitude of different exercise types. The all-purpose multiple choice questions and fill-in exercises are available and were utilized on the course. Other, more specific exercise types used on the course were binary calculations, the number-base conversion exercise, an algorithm visualization exercise, programming exercises and Parson's puzzles. Only the multiple choice and fill-in exercises were used early in the course, and the algorithmic and programming exercises were introduced after the half-point in the course, when more programming-oriented topics were discussed. Next the exercise types are explained in more detail.

The multiple choice questions and the Fill-in exercises were used to test a wide array of topics, including Signal-to-Noise ratios, number of bits transferred over networks and OSI-model. The ViLLE multiple choice question exercise allows for short open questions, in addition to the familiar question-and-several-choices format. As both these modes are automatically assessed, students are given feedback on the correctness of their answer immediately upon answering. Additionally, in case of an incorrect answer, the students were provided with an explanation why the given answer was incorrect. Moreover, the open-ended questions can be randomized to provide different numeric values for, example, file sizes or network bandwidths for each attempt. This is an effective method to ensure students have a basic understanding for what is being asked, as they cannot merely copy the answer since all students have effectively different question parameters.

The algorithm visualization exercise is implemented using the JavaScript Algorithm Visualization (JSAV) library (Karavirta& Shaffer 2013) and was used to visualize execution of various sorting algorithms. The algorithm was visualized with pop-up questions at key points of the algorithm, all questions were automatically assessed and feedback was given to the students on where they went wrong. Because students only had a very cursory knowledge of programming concepts, visualizing the execution of the different algorithms was meant to not only teach them the workings of said algorithm, but enforce the concepts of looping and branching as well.

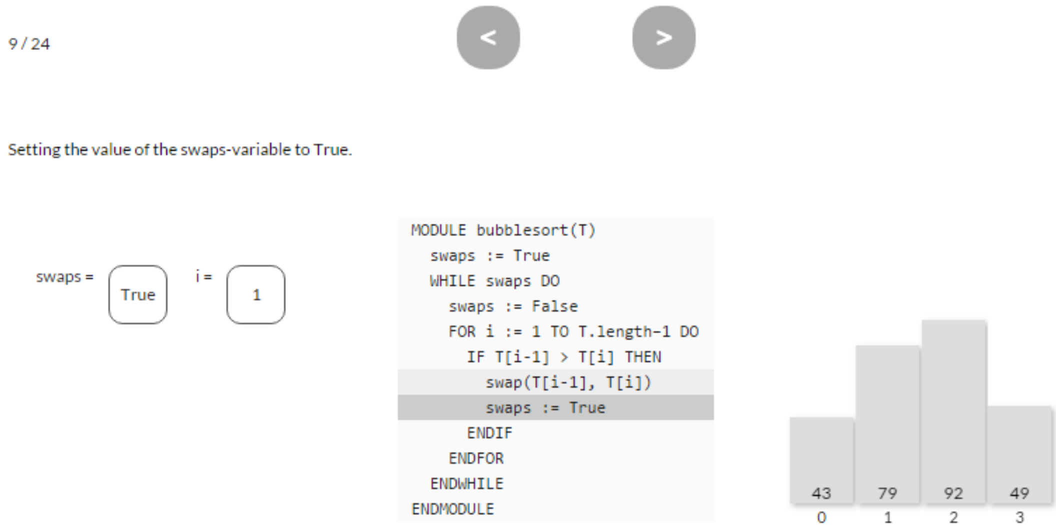

Figure 1. JSAV visualization exercise

The binary calculations in ViLLE are an interactive version of calculating binary calculations column by column. The main benefits of this exercise in comparison to calculating on paper are the possibility to automatically assess the answers and the immediate feedback students receive. The binary calculations in ViLLE are randomly generated from parameters given by the teacher. Immediate feedback in the binary calculation exercise consists of showing the student the correct answer to the given problem.

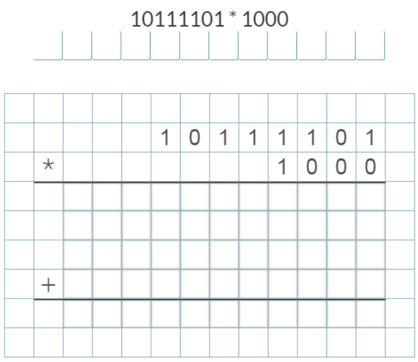

Figure 2. Binary calculations

Parsons' problems (Parsons 2006) are a programming exercise, where the student is given ready program code, but in an incorrect order (Fig). The given program code must then be ordered correctly, usually by dragging and dropping the rows of code to the correct order. Parsons' exercises have been found to involve a similar skill set as that of writing code (Denny, 2008). During this course, students were taught a cursory understanding of basic control structures and syntax, which means that students recognize loops and branching in code, but may not be able to write working programs in the same programming language. Parsons' problems were then used to practice algorithmic thinking and problem solving without the need to memorize and write actual program code.

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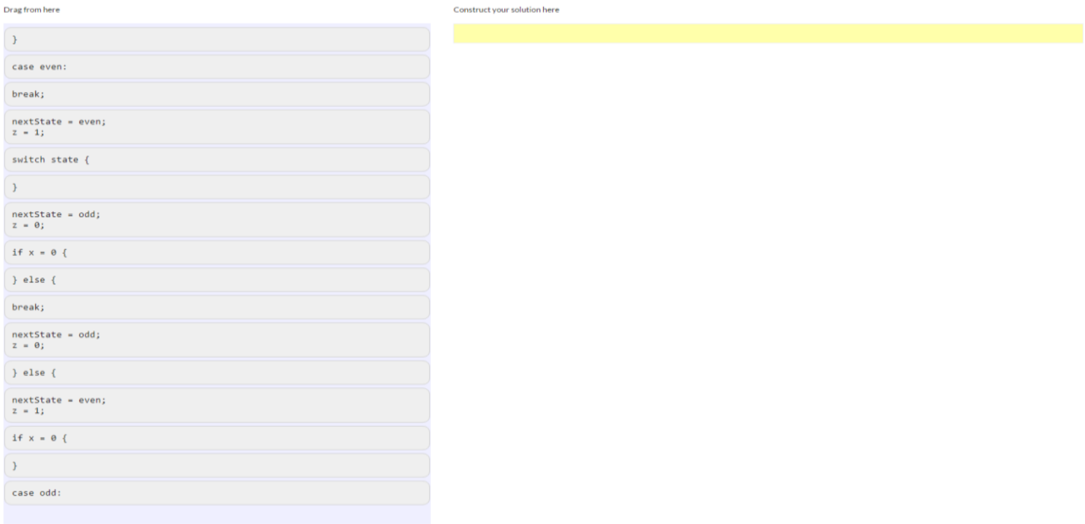

Figure 3. Parsons' problem

4. REFACTORING THE COURSE EXAM

As part of the development, the course exam was decided to be organized in an electronic form by using ViLLE. There are several reasons to use electronic exam instead of pen and paper. First, by using a suitable tool, the answers can be automatically assessed, which drastically decreases the course staff's workload and quickens the evaluation process. Second, using an electronic exam enables the usage of authentic coding (or code constructing) exercises with possibilities for compiling, testing and debugging the code before submission. Thirdly, an electronic exam provides a possibility for randomizing the exercises and exercise parameters, which makes it possible to offer more heterogenic exams.

Since ViLLE was used comprehensively in the course for practicing the topics and for recording attendances, it was decided to be used as an exam platform as well. The students were already familiar with the system, which meant that students' cognitive load (see for example De Jong, 2010) was not unnecessarily increased in the final exam. The exercises were selected to resemble the ones practiced during the course. The exam structure is displayed in Table 1.

Table 1. The course final exam structure

Question #	**Type**	**Description**
1a, 1b and 1c	MCQ and open questions	Multiple choice and open questions about all topics in the course with emphasis on theory.
2a	MCQ	OSI Model: question about each level in the model
2b	Questions	Questions about processor technology and other technology
3a and 3b	Conversion	Binary / decimal / hexadecimal conversions between all formats
3c	Logical operations	Logical operations using bit patterns
3d and 3e	Questions	Calculations and format conversions
3f	Questions	Questions about SNL ratio and sine signal
3g	Calculations	Huffman coding
3h	Calculations	FIR, DFT and FFT algorithm
4a	Algorithm visualization	Simulating a bubble sort or insertion sort algorithm
4b and 4c	Code construction	Building a pseudo code algorithm using given code lines
4b and 4c (alternatively)	Coding	Writing a program according to given specifications using either Python or C

Most of the questions are either initialized with random parameters, or contain a pool with five or more alternatives of questions. One of these questions is randomly assigned to each answerer. The questions are varied between instances, but the basic principles stay quite similar. Since 2013 instance, the students could have chosen either a code construction or a coding exercise in the two final tasks, and in the final instance (2015) construction exercises were provided solely instead of coding exercises. This was mainly done because programming is taught in other introductory courses. An example of a code construction exercise is displayed in Figure 4.

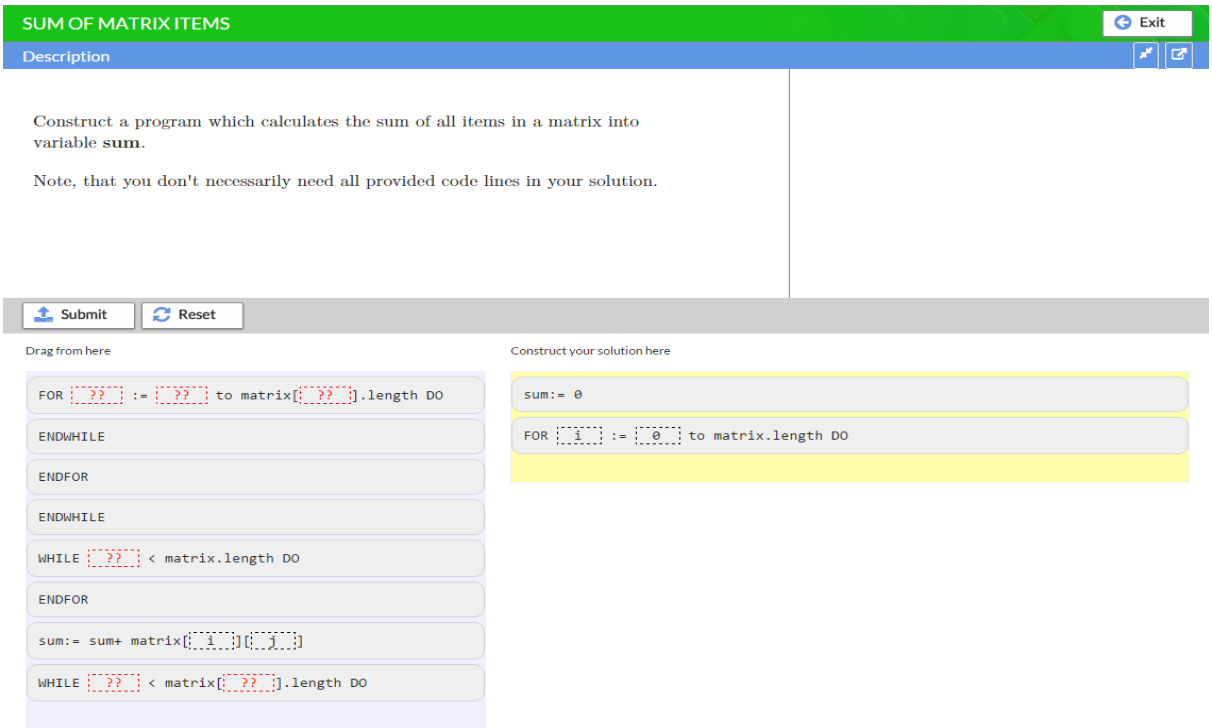

Figure 4. Code constructing exercise in ViLLE's exam mode. Note, that some of the code lines are parameterized

Although the electronic exams in our university are usually supervised, the exam for the CS 0 course was decided to be organized as unsupervised. This meant, that the students could take the exam wherever they wanted by using their own computers. A possibility to take the exam in the computer lab was still provided for students who could not use their own computers. The exam start and end times were still restricted, meaning that all students took the exam at the same time.

Since most of the questions were randomized, the supervision was not deemed necessary. It is likely, that some students provided assistance to other students during the exam, but because of randomization and question pools it is highly unlikely that two students taking the exam at the same premises answered to more few same questions. Moreover, we wanted the students to be able to use internet and other necessary resources to help them solve the tasks, as this is usually the case when they are applying the skills into real-life problems later.

5. RESEARCH SETUP

The course was designed and utilized at 2012. The results are observed from four instances (2012 to 2015). The number of participants (excluding the students from other departments) in the instances are displayed in Table 2.

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Table 2. Instances of the course following the new design

Year	2012	2013	2014	2015
N	71	61	46	29*[1]

The significant decrease in number of students taking the course between instances of 2013 and 2014 was due to changes in the department's curriculum. While in 2012 and 2013 both, computer science majors and the engineering students (with IT major) took the course (along with other students from the faculty), a new specialized course was designed as a replacement for CS majors in 2014.

For comparison, results of the old course instances between 2009 and 2011 are also presented, though the major changes in course content, method and personnel mean that not fully valid comparisons can be made; this is also further addressed in the Discussion section. The number of participants in instances of 2009 to 2011 is displayed in Table 3.

Table 3. Instances of the course with the old design

Year	2009	2010	2011
N	77	83	58

In addition to grade averages of the old and redesigned course instances, the ViLLE scores obtained as well as the average number of attendances are also displayed. ViLLE automatically collects a huge amount of data about the submissions made, including for example the scores, submission times and the time spent on each individual task.

6. RESULTS

The grade averages (in scale of 1 to 5, where 5 is the best) of all course instances are displayed in Table 4.

Table 4. The grade averages of all course instances following the new design

Year	2012	2013	2014	2015
Grade average	4,15	4,54	3,78	3,59*[1]

As seen in the table, there is a slight drop in the course average between instances of 2013 and 2014. The main difference between years 2013 and 2014 is the decrease in number of students taking the course, as a separate course for computer science majors was started at 2014. Hence, there were only engineering students with information technology major at instances of 2014 and 2015. The content of the course was change at 2014 accordingly.

For comparison, the grade averages for old course instances are also displayed in Table 5.

Table 5. The grade averages of all course instances following the old or new design

Course	Old	Old	Old	New	New	New	New
Year	2009	2010	2011	2012	2013	2014	2015
Grade average	3,55	3,05	3,12	4,15	4,54	3,78	3,59

As seen in the table, the students' grade averages seem to be higher in the new course. This can be confirmed by calculating the averages of the old course instances (total N = 217, average = 3.2569) and the new instances (N = 207, average = 4.10628). The difference is statistically significant, with $p < 0.01$ (calculated with Wilcoxon non-parameterized rank-sum test). However, as stated before (and readdressed in

*[1] The data for 2015 was not conclusive when this article was written, as there were still revision exams to be held for the course.

the discussion), the comparison of the courses is not fully valid because of changes in the content, methodology and course staff.

The student activity in ViLLE was compared to grade obtained in each instance. The results are displayed in Figure 5.

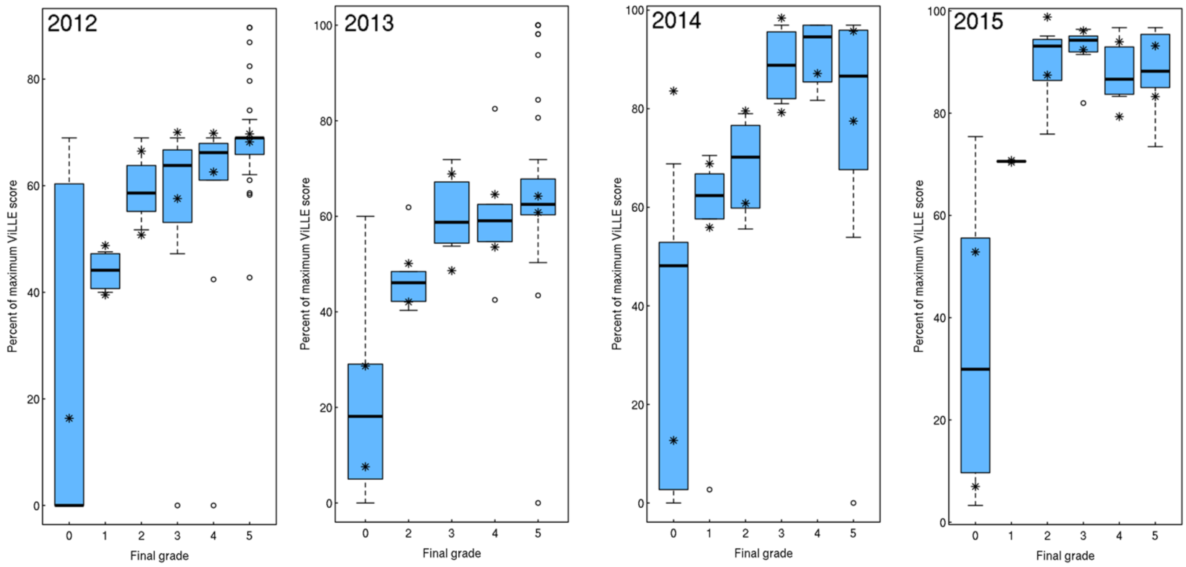

Figure 5. The relationship between course grades and the amount of ViLLE exercises completed during the course

In each of the images in the figure, the final grade is displayed in the X-axis and the percentage of ViLLE exercises done in the Y-axis. As seen in the figure, at each instance the students who worked the hardest during the course also got the higher grades.

The attendances in the course lectures were recorder by using RFID devices and RFID tags or cards given to students. ViLLE automatically registered an attendance when a tag was used with a reader in a lecture hall. The average number of attendances is displayed in Table 6.

Table 6. The average amount of attendances in the course lectures

Year	**2012**	**2013**	**2014**	**2015**
Attendance avg.	5,05 of 7	4,32 of 6	5,98 of 7	5,25 of 7
% of maximum	72,14%	61,71%	85,43%	75%

As seen in the table, the attendance rates were higher at the latter instances (2014 and 2015) when the attendees were engineering students only. Hence, it seems that the major students are more likely to attend the lectures than others

7. DISCUSSION

It seems that the design of the new course was successful. The thorough utilization of educational technology and the new exercise types designed encouraged students to work quite hard. Moreover, it seems that the students who answered to most exercises also got the highest grades. There are some differences between the instances of the new course, for example the grade average decreased a little between instances of 2013 and 2014. There are a few likely explanations for this: first, the course content was altered between the aforementioned instances to better fulfil the specific demands of our engineering education. At the earlier instances the content needed to be suitable for students with other majors as well. Moreover, the data for the latest instance was not comprehensive when this article was written, as there were students who had not taken the exam yet (and some students who were likely to retake the exam to improve their grade), so the grade average for 2015 is likely to increase from the currently reported.

The students also seemed to participate into lectures quite actively. Notably, when the course consisted of engineering students only (instances 2014 and 2015) the average number of attendances was higher than in the earlier instances. It is likely, that the engineering students find the topic more interesting and more relevant to their other studies, and hence attend the lectures more than students with other majors (such as math or physics majors).

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TEACHING DATA SCIENCE TO POST GRADUATE STUDENTS: A PRELIMINARY STUDY USING A "F-L-I-P" CLASS ROOM APPROACH

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ABSTRACT

Data is everywhere. As a result the need for data scientists with the correct skill set to analyze and interpret the data has escalated. Not surprisingly, data scientists are currently one of the most wanted professions. Tertiary institutions are faced with the challenge of producing students with the correct blend of theoretical knowledge and practical skills. In an attempt to provide current post-graduate students with these skills, a flipped class room approach was adopted to teach students data warehousing as part of the data science curriculum. This paper used the four pillars of F-L-I-P (FLN 2014) to analyze data obtained from lecturer implementation experience and student course evaluation forms. It was shown that great strides have been made in this course in the adoption of the flipped class room although there is room for improvement in order to achieve flipped learning. The outcome of the study directly contributes to the improvement of subsequent implementations of the module.

KEYWORDS

Data science, data warehousing, flipped class room, F-L-I-P

1. INTRODUCTION

Data science is a relatively novel discipline (Song & Zhu 2015; Provost & Fawcett 2013) born as a result of the need to capitalize on vast volumes of data, also referred to as "big data". It is a combination of older disciplines such as mathematics and statistics as well as the newer discipline of computer science (Provost & Fawcett 2013). The multidisciplinary nature of data science has created a challenge to educational institutions to provide students with the necessary blend of knowledge and skills to fill the anticipated need for competent data scientists (Provost & Fawcett 2013). The unique blend of knowledge and skills are often challenging to teach in a traditional class room environment (Turek et al. 2015).

In an attempt to address the challenges associated with the traditional class room environment a blended learning approach is suggested. Blended learning is a method whereby different types of education methodologies and technologies are adopted to provide more "effective education experiences" (Köse 2010). As a result, a combination of older traditional face-to-face models and online technologies are utilized in the teaching model.

The flipped class room approach is one of many blended learning approaches. Bishop and Verleger (2013) describes this method as *"a new pedagogical method, which employs asynchronous video lectures and practice problems as homework, and active, group-based problem solving activities in the class room"*. Therefore, the traditional activities conducted in the class room and at home is switched (or "flipped" / "inverted"), i.e. lectures are watched at home whilst homework questions are discussed in class (Herreid & Schiller 2013; Bishop & Verleger 2013). A flipped class room approach was adopted in the teaching of a post graduate data warehouse semester course under the umbrella discipline of data science. A flipped class room approach was adopted for three main reasons:- 1) to improve the learning experience of students; 2) face-to-face contact time was limited (one contact session every fortnight) and the total number of concepts could not be covered in detail during these sessions; and 3) the course was presented on post-graduate level where the requirement was that students should master a higher level of thinking skills than the traditional recall type testing. A flipped class room approach seemed more applicable to provide a more in-depth presentation of concepts.

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The main objective of the study was to compare student evaluations and lecturer implementation experience of traditional teaching methods (2013 and 2014 cohort) with a flipped class room approach (2015 and 2016 cohorts). As this was the first time that a full flipped class room approach was adopted in the course (as opposed to a partial flipped class approach in 2015 and traditional approach in 2013 and 2014), the main aim was to evaluate the extent to which flipped learning was achieved by using the four pillars of the F-L-I-P (FLN 2014). The anticipated contribution is to identify areas of success and improvement of the 2016 cohort. This can contribute to the successful implementation of the teaching of data science related subjects in general.

The outline of the paper is as follow: the four pillars of F-L-I-P is described followed by a discussion on the approach in the context of data science. The methodology and data is presented followed by a discussion and conclusion.

2. THE FOUR PILLARS OF F-L-I-P

Further to the brief definition of the flipped class room provided above, the four pillars of F-L-I-P is one of many pedagogical models developed to support educators to transition from a traditional class room to a flipped class room. Examples of models included ATRACT (Coley 2012) which describes issues to be aware of when considering to implement a flipped class room and CPBL (Warter-Peres and Doug 2012) that suggest that learning should take place outside the class room which will then allow learners to complete problem based learning activities in the class room assisted by their peers and educators.

Flipped Learning Network (FLN 2014) defined the four pillars of flipped learning in order to make the very important distinction between FLIP class room and FLIP learning. It is argued that although a number of educators might employ the FLIP class room approach by giving students preparatory work, it is not clear whether any learning takes place. FLIP learning is defined as *"a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter"* (FLN 2014:2). In order to ensure that learning takes place in a flipped class room they propose four pillars of F-L-I-P where each pillar has a number of specific objectives to be met. Each of these pillars will be briefly introduced in turn. These pillars will be used in section 5 as the analytical lens through which the data will be discussed.

2.1 Flexible Environment

The "flexible environment' pillar refers to both the physical as well as the virtual student engagement space. It caters for both individual and group interactions. The flexibility of the pillar refers to the anytime and anywhere access and engagement with the learning environment. A flexible learning environment can be enhanced by technology, for example web 2.0 tools. These tools can *"encourage active learning, promote collaboration, increase student-faculty interaction and enrich educational experience"* (Mandernach & Taylor 2010). Students can therefore select "when and where" they learn. From a lecturer perspective the expectation of student timelines for learning and assessments is flexible as long as key deadlines are met.

2.2 Learning Culture

Learning culture refers to moving away from the traditional teacher-centered approach where the teacher is the primary source of information to a learner centered approach where in-class contact time is utilized to discuss topics in greater detail therefore creating a richer learning opportunity. As a consequence students are *"actively involved in knowledge construction as they participate in and evaluate their learning in a manner that is personally meaningful"* (FLN 2014).

2.3 Intentional Content

Intentional content refers to the learning material to be used to cultivate the student's conceptual understanding as well as practical application of concepts. Facilitators or lecturers should therefore carefully consider both the content as well as presentation method of material prior to contact sessions to maximize the effectiveness of these sessions. The objective should be on achieving the best possible learning experience for the student by a combination of student self-discovery and theoretical material.

2.4 Professional Educator

The educator in a flipped class room can be compared to a “silent partner” and facilitator. As a result the role of the lecturer can be much more demanding when compared to a traditional class room setup. Furthermore the lecturer requires a more specialized skill set than in a traditional class room. Continuous feedback by the educator is of utmost importance in the learning process. Contact sessions are often characterized by “chaos” but with constructive feedback.

3. FLIPPED CLASS ROOM FOR THE DATA SCIENTIST

Earlier research in the field of science, technology, engineering and mathematics (STEM), of which data science is a subset of, has focused on the implementation of the flipped class room approach for teaching STEM.

In a study conducted by Fulton (2012) based on teaching Calculus 1, it was found that the flipped class room approach as a positive allowed: (1) Students the opportunity to study at their own pace; (2) Students who experienced difficulties to be identified and assisted during the learning process; (3) The curriculum to be adapted to address difficult concepts according to the student’s needs; (4) Contact-time to be used in a constructive way; and (5) Students to be more interested in the subject. However, as a negative, students new to the concept of the flipped class room approach perceived the “homework” as additional work. As a result, not all the students conducted the additional preparatory homework assignments. Homework had to be developed and customized to the level of the student. As a result, this approach was time intensive for the lecturer.

The content of data science curriculums are a topic of much discussion amongst academics (Song & Zhu 2015; Tang & Sae-Lim 2016; Yi 2016; Dubey & Gunasekaran 2015). Whilst the focus of data science curriculum related studies are mainly on what should be included, a few studies have now started to focus on how data science related subjects should be taught. Turek, Suen and Clark (2015) argued that in order to prepare data scientists for “the real world” data science education should adopt a multi-disciplinary approach based on experiential learning (flipped class room) methodology. They have called for three considerations in designing data science courses: Firstly, “real-world projects” should be used in order to present students with accessible data and in a real world context, secondly team dynamics on a project level was surprisingly an important factor in the successful operation of the research team and finally early introduction of technical tools is recommended in order to ensure effective team dynamics. As a result a multi-disciplinary approach to data science education is proposed in order to deal with both the technical and team dynamics.

A study conducted by Dichev et al. (2016) focused on adopting an active participatory learning approach in contrast with the passive learning approach to teaching an introductory data science course. They agreed with Turek, Suen and Clark (2015) that a learner centered approach which they called a “flipped learning model” is needed to cater for the multidisciplinary requirements of the subject. A phased approach is suggested in developing the data science course.

4. DATA AND METHODOLOGY

One of the courses presented as part of the data science education path at a tertiary institution in South Africa is data warehousing. This semester module was presented to post graduate students (4^{th} year level) who complied with the pre-requisite of completing any relevant undergraduate database-related subject.

The main objective of the data warehouse semester module was to introduce students to the concept of data warehousing that supports business intelligence (BI) in an organizational environment. Although the emphasis was on basic data warehousing concepts without disregarding the influence of big data and disruptive technologies currently changing the landscape. Despite these technologies the fundamentals of data warehousing and business intelligence remain relevant and provided the departure point to acquire the necessary knowledge to work with structured data.

The course covered six topics namely an overview of the concepts of data warehousing and business intelligence (BI); the planning, design, architecture and infrastructure of data warehousing; data design and preparation focusing on dimensional modeling as well as the loading of data (extract, transform and loading) and data quality; information delivery and online analytical processing (OLAP); and finally the implementation, deployment and maintenance of the environment. For each of the topics, a theoretical section introduced the student to the topic followed by a practical component whereby students had the opportunity to apply the theoretical concepts. The course was presented to a diverse student group. The student groups were diverse both in terms of demographics and academic background. A total of 55 students participated in the course of which 34 were males and 21 females.

An open book approach was adopted. Students were permitted to have access to any of the study materials available. No test recall type questions were asked during assessments. The approach was as follow: one day prior to the class contact sessions, scheduled every fortnight, students had to complete a preparation assignment using the online learning environment. This preparation was based on the material to be covered during the subsequent class contact session. In order for students to complete the assignment successfully they had to work through the respective chapters in the prescribed book as well as watching general videos on the topic available through the learning management system. Students were encouraged to complete these assignments in order to prepare them for the class discussions during the contact sessions. A total of four assignments were available which contributed a substantial amount towards the final semester mark.

The data used in this study was collected from anonymous student evaluations after the course of the cohort 2013 and 2014 which followed a traditional teaching approach as well as a partially flipped class approach in 2015 and a full flipped class room approach in 2016. The evaluation sheets allowed students to score their experience of the module on a Likert scale where 1 is poor and 5 is excellent. There was also ample provision for students to provide written feedback on each of the evaluation areas. These evaluation areas included module content (organization, study material, usefulness of material and usefulness of the course), lecturers (interpersonal relationships, level of knowledge, attitude, preparation and use of media as well as learning opportunities) and assessment (clarity of criteria, nature, content and method as well as fairness), level of difficulty, workload and provision for free text general comments. Table 1 contains a summary of the individual scores per category for the different cohorts. The class contact sessions followed the following structure: key theoretical concepts were covered in class by the lecturer where after the group class discussions followed to practically apply the concepts covered.

The assessment structure for all the cohorts of the module included an semester test, a practical project as well as a final written examination. For the practical project students were provided with a number of data files. Based on a real life business case and business problem students had to use these data files to construct a data warehouse environment containing the data in such a way that the data is available for analysis. The students then had to solve the identified business problem and suggest recommendations by presenting their findings using a presentation layer (graphs / reports / analytical structures).

Table 1. Summary of student evaluation scores

	Average score			
	2013	**2014**	**2015**	**2016**
Area of evaluation				
Module content	**4.29**	**4.00**	**4.04**	**3.73**
Organization (of the course)	4.23	3.85	3.98	3.92
Study material	4.32	4.15	4.14	3.92
Usefulness of material	4.23	3.85	3.90	3.46
Usefulness of course	4.38	4.15	4.15	3.62
Lecturers	**4.43**	**3.99**	**4.28**	**4.03**
Interpersonal relationships	4.58	4.33	4.10	4.08
Level of knowledge	4.51	4.11	4.17	4.23
Attitude	4.6	4.41	4.29	4.23
Preparation, use of media	4.28	3.52	4.31	3.77
Learning opportunities	4.13	3.59	4.52	3.85

	Average score			
	2013	**2014**	**2015**	**2016**
Area of evaluation				
Assessment	**4.02**	**3.87**	**4.14**	**3.82**
Clarity of criteria	3.92	3.81	4.02	3.69
Nature, content and method	3.94	3.85	4.07	3.77
Fairness	4.20	3.95	4.33	4.00
OVERALL AVERAGE	**4.28**	**3.97**	**4.16**	**3.88**

The institutional acceptable average of a 4th year level course evaluation is 3.6. Important to note is that none of the course evaluations specifically references the traditional or flipped class room methodology. Therefore the student responses are indicative of their overall experience of the methodology.

The difference between the average scores obtained for the cohort 2013 and 2014 were vastly different. This was interesting as the course was presented by the same lecturer using the same material and teaching approach (traditional). A possible explanation might be the diversity of the student group for the two years in question. However, this would have to be further investigated. Surprisingly the average score obtained in 2015, when the flipped class room approach was adopted for the first time, was higher than the score obtained in 2016. Further investigation showed that this could be attributed to the fact that a "partial" flipped class room approach was adopted in 2015. For example, in 2015 students were required to read the allocated chapters prior to the class contact sessions. Class discussions were then based on the material covered. In 2016 students were also required to read the allocated chapters but then had to complete online questions and tasks.

For the purpose of this study the student feedback on the module content is of specific interest. In 2016 the flipped class room approach was fully implemented whilst in 2015 it was partially implemented (similar to the phased approach by Dichiev et al. 2016). This might explain the decrease in the overall student evaluation average (from 4.04 to 3.73).

The variance in scores for the lecturer section is very subjective. For every cohort a different student group with diverse demographics participated in the research. However, the same lecturer presented the course in 2013 and 2014. The appointed lecturer changed in 2015 and again in 2016. A possible explanation of the variance might be the different personality and presentation styles of lectures.

For the cohort years of 2013 to 2015 the assessment structures were the same. However, for the cohort 2016 online pre-class assessments were included in the assessments structure. This implied that there was an increase in individual workload prior to class contact sessions. Students indicated in the general section of the course evaluation feedback that the workload was intense therefore scoring the assessment section lower.

5. DISCUSSION

The data obtained from the various cohorts are discussed using the different pillars of the F-L-I-P learning approach (see section 2). This approach fitted well with the categories evaluated on the student evaluation feedback sheets namely module content (intentional content of the F-L-I-P learning approach), lecturers (professional educator of the F-L-I-P learning approach) and assessments (flexible environment and learning culture of the F-L-I-P learning approach).

5.1 Flexible Environment

According to FLN (2014) a flexible environment is achieved by meeting three objectives:

Establish spaces and time frames that permit students to interact and reflect on their learning as needed. In the flipped class room approach (2016 cohort) the lecturers tasked students to conduct activities prior to face-to-face contact sessions by performing online preparatory homework assignments. The learning process was further substantiated by online discussions using a learning management system, online videos and discussions during class contact sessions. Despite the effort by lecturers students felt that the learning opportunities created when a full flipped class room approach was followed was not adequate enough (2016 cohort) when compared to the previous year when a partial flipped class room approach was followed.

Student feedback in cohort 2014 requested more assessment opportunities as well as more supportive media such as videos.

Continually observe and monitor students to make adjustments as appropriate.

The feedback received from the grade system from the preparatory assignments prior to the class contact sessions were used as mechanism to establish the level of knowledge of students. This was used to prepare material for in class contact sessions.

Provide students with different ways to learn content and demonstrate mastery.

Online activities, class-contact sessions and a final practical project provided students with various ways to demonstrate that the required level of knowledge and skills has been achieved. This is similar to the approach adopted by Turek, Suen and Clark (2015).

5.2 Learning Culture

According the FLN (2014) a learning culture is achieved by achieving the following two objectives:

Provide students with the opportunity to engage in meaningful opportunities without the teacher being central.

One of the many advantages of a flipped class room approach is the ability to use contact time more effectively and creatively. However, the students perceived pre-class preparatory assignments as additional work adding to their workload. This is a typical challenge identified by Herreid and Schiller (2013) of students that are new to this concept. Often student resistance is experienced by students new to this approach. This was therefore in line with the responses received of this study. The online management system provided students with the opportunity to engage with peers on specific topics established by the lecturer as illustrated by figure 1. Although the initial topic was established by the lecturer self-propelled student engagement was encouraged.

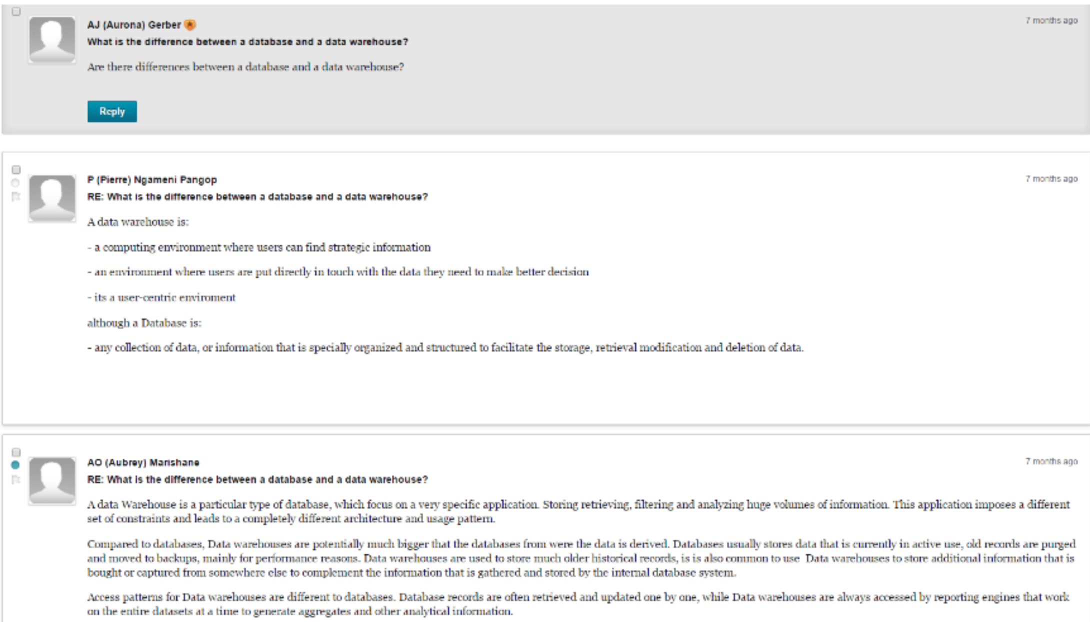

Figure 1. Example of discussion forum

Scaffold these activity and make then accessible to students through differentiation and feedback.

Due to the complexity of the topic (data warehousing) and new technical concepts introduced it was imperative for discussions to complement one another in order for students to conceptualize the new domain. For example the first topic for discussion was the difference between a database and a data warehouse (see figure 1 for example). Consequently the lecturer pitched the class discussion according to her observation of the student's understanding of the concept. The second activity was the need for data warehousing. This activity complimented the first activity by extending the understanding of a data warehouse and at the same time contextualizing the need for this module.

5.3 Intentional Content

Feedback from the student evaluation sheets scored the module content area at 3.73 (2016). This is higher than the minimum average required but the lowest for all the cohorts under consideration. This might indicate that the module content for a flipped classroom needs further investigation to establish what is expected.

According the FLN (2014) a learning culture is achieved by achieving the following three objectives:

Prioritize concepts used in direct instruction for learners to access on their own.

The meaning of the term "data science" is a much debated topic amongst both practitioners and academics (Provost & Fawcett 2013). This can be attributed to the fact that the term is relatively new borrowing concepts from various disciplines (Song & Zhu 2015). The concept also includes new, ill-defined concepts such as big-data and data analytics. Some authors perceive data science as part of the overall concept of "Business Intelligence and Analytics" (BI&A) with a strong focus on the business application of data analytics (Chen, Chiang & Storey 2012). As a result of this ongoing discourse lecturers had great difficulty in identifying and prioritizing of key concepts in preparing students for the "real world".

Create and/or curate relevant content (typically videos) for students.

One of the requirements to implement a flipped class room approach was the customization of preparatory work (Herreid & Schiller 2013). A great deal of work went into the development of online preparatory assignments. This has created an additional workload on the lecturers. But despite the effort, students did not perceive the module content to be extremely useful and organized. However, the module met the expectations of the majority of students. General course videos on the sub-topics were made available on the learning management system. This allowed students to gain an initial understanding of the concepts covered. It also contextualized the concepts using real world examples.

Differentiate to make content accessible and relevant to all students.

Although students did not mention the challenges associated with accessibility of online material, lecturers take cognizance of the fact that this might be a problem in a country such as South Africa, frequently characterized by power outages and high data costs.

5.4 Professional Educator

Feedback from the student evaluation sheets scored the lecturer area at 4.03 (2016) which is second lowest of the cohorts under consideration. Although the student feedback indicated that the lecturer was "knowledgeable" and "professional" further research is needed to understand the student's perception of the lecturer's role in a flipped class room.

According the FLN (2014) a learning culture is achieved by meeting the following three objectives:

Make myself available to all students for individual, small group, and class feedback in real time as needed.

At the start of the semester the learning management system was used to communicate pre-arranged consultation hours to students. Lecturers could also be contacted at any time using online media and additional consultation sessions was available on request. The online discussion forum was monitored and feedback provided where applicable.

Conduct ongoing formative assessments during class time through observation and by recording data to inform future instruction.

Formative assessments were conducted by providing ample opportunity for groups to discuss topics amongst themselves where after one group spokesperson had the opportunity to provide consolidated feedback to the entire class.

Collaborate and reflect with other educators and take responsibility for transforming practice.

This was one of the first modules in the department to follow this approach. The approach followed in 2016 was based on the partial flipped class room approach adopted by the lecturers in 2015. Future collaboration sessions are planned to improve on the implementation of the approach in 2017.

6. CONCLUSION

In an attempt to equip potential data scientists with the correct blend of practical and academic knowledge and skills a flipped class room approach was adopted in a post graduate data science course. Subsequently, the aim of this study was to determine to what extent flipped learning was achieved.

The study compared student evaluations and implementation experience of traditional teaching methods (2013 and 2014 cohort) with a flipped class room approach (2015 and 2016 cohorts). The four pillars of F-L-I-P was used as analytical lens and explains the extent to which flipped learning was achieved.

The findings suggested that great strides have been made in the implementation of a flipped class room approach in particular a flexible learning environment as an online learning management system have been utilized by other post graduate modules. The challenge was that the learning culture of the students still has some adjustment to be made. This is not surprising as it supports previous findings.

The findings of the study further indicated that there is scope for improvement on the provision of customized content in the context of South Africa. The study further suggested that ongoing formative assessments perhaps required more attention as well as collaboration efforts with other lecturers.

The study can be seen as exploratory as the data obtained for the study was based on standard student evaluation feedback forms. Further research incorporating learning analytics and in-depth interviews with learners will be conducted to get a more informed understanding of the effectiveness of the flipped class room approach.

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EDUCATIONAL ROBOTS IN PRIMARY SCHOOL TEACHERS' AND STUDENTS' OPINION ABOUT STEM EDUCATION FOR YOUNG LEARNERS

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ABSTRACT

The article discusses issues related to STEM education; it is emphasized that the need to prepare students with twenty-first-century skills through STEM-related teaching is strong, especially at the elementary level. The authors stress that workshops, using kits to build and program robots, are a modern form of interdisciplinary education of children and youth. The rationale for conducting such activities in schools is found in the European reference framework in the context of training of key competences. Classes in robotics – properly taught – will have an impact on the development of mathematical literacy and scientific-technical information and social competences. At the same time, competence is understood to mean a combination of knowledge, skills and attitudes appropriate to the situation. Besides, an analysis is presented of basic legal regulations in this matter as well as some results of a survey, conducted in Poland and Ukraine among in-service teachers and prospective teachers.

KEYWORDS

Robotics in school, survey, competences, STEM education

1. INTRODUCTION

The need to prepare students with twenty-first-century skills through STEM-related teaching is strong, especially at the elementary level. However, most teacher education preparation programs do not focus on STEM education. The authors' (Schmidt, Fulton 2016) findings suggest that while inquiry-based STEM units can be implemented in existing programs, creating and testing these prototypes requires significant effort to meet PSTs' learning needs, and that iterating designs is essential to successful implementation.

Other authors (Kim et al. 2015) report a research project with a purpose of helping teachers learn how to design and implement science, technology, engineering, and mathematics (STEM) lessons using robotics. Specifically, pre-service teachers' STEM engagement, learning, and teaching via robotics were investigated in an elementary teacher preparation course. Data were collected from surveys, classroom observations, interviews, and lesson plans. Both quantitative and qualitative data analyses indicated that pre-service teachers engaged in robotics activities actively and mindfully. Their STEM engagement improved overall. Their emotional engagement (e.g. interest, enjoyment) in STEM significantly improved and in turn influenced their behavioural and cognitive engagement in STEM.

Identifying 21st Century STEM Competencies Using Workplace Data (Jang 2016). Gaps between science, technology, engineering, and mathematics (STEM) education and required workplace skills have been identified in industry, academia, and government. Educators acknowledge the need to reform STEM education to better prepare students for their future careers. Jang (2016) pursues this growing interest in the skills needed for STEM disciplines and asks whether frameworks for 21st century skills and engineering education cover all of important STEM competencies. Researchers identify important STEM competencies and evaluate the relevance of current frameworks applied in education using the standardized job-specific database operated and maintained by the US Department of Labor. An analysis of the importance of 109 skills, types of knowledge and work activities, revealed 18 skills, seven categories of knowledge, and 27 work activities important for STEM workers.

The authors Uttal David H. and Cheryl A. Cohen in own research (2012) stressed that there is little doubt that the United States faces a serious challenge to educate citizens who can perform jobs demanding skill in science, technology, engineering, and mathematics (STEM) domains. They explore the relation between spatial thinking and performance and attainment in science, technology, engineering and mathematics (STEM) domains. Spatial skills strongly predict who will go into STEM fields. But why is this true? Researchers Uttal and Cohen in own study (Uttal, Cohen 2012) argue that spatial skills serve as a gateway or barrier for entry into STEM fields.

The global urgency to improve STEM education may be driven by environmental and social impacts of the twenty-first century which in turn jeopardizes global security and economic stability (Kelley & Knowles 2016). The complexity of these global factors reach beyond just helping students achieve high scores in math and science assessments. Friedman (The world is flat: A brief history of the twenty-first century, 2005) helped illustrate the complexity of a global society, and educators must help students prepare for this global shift. In response to these challenges, the USA experienced massive STEM educational reforms in the last two decades. In practice, STEM educators lack cohesive understanding of STEM education. Therefore, they could benefit from a STEM education conceptual framework. Table 1 provides critical elements of distinction between these two views of technology (T) one of the important category of STEM.

Table 1. Two views of technology

Engineering perspective of technology	**Humanities perspective of technology**
Technology consists of:	Technology can be viewed as:
A distinct body of knowledge	More than a sum of tools, instruments, artefacts, processes, and systems
An activity or a way of doing	Influences the structure of the cultural/ social order regardless of its user intentions
Design, engineering, production, and research procedures	Serving human values and influence value formation
Physical tools, instruments, and artefacts	Autonomous social and economic forces that often override traditional and competing values
Organized integrated systems and organizations that are used to create, produce, and use technology	Capable of unanticipated positive as well as destructive social and economic consequences

Source: Todd R. Kelley, J. Geoff Knowles (2016) based upon Herschbach 2009

Mitcham (1994) combines these two views together when he identified four different ways of conceptualizing technology. He identifies technology as (a) objects, (b) knowledge, (c) activities, and (d) volition. Often, people associate technology as artefacts or objects; unfortunately, many only view technology in this way and overcoming this limited view of technology may be critical for teaching STEM in an integrated approach.

Additionally, the concept of learning as an activity not only leverages the context of the learning but also the social aspect of learning. Lave and Wenger (1991) describe this as legitimate peripheral participation when the learning takes place in a community of practitioners assisting the learner to move from a novice understanding of knowledge, skills, and practices toward mastery as they participate "in a social practice of a community" (p. 29) (Todd R. Kelley, J. Geoff Knowles 2016).

2. ROBOTICS AND CHILDREN. SELECTED LEGAL REGULATIONS

2.1 Proprietary Proposals

Workshops using kits to build and program robots are a modern form of interdisciplinary education of children and youth.

The rationale for conducting such activities in schools is found in the European reference framework in the context of training of key competences.

Classes in robotics – properly taught – will have an impact on the development of mathematical literacy and scientific-technical information and social competences (see Figure 1). Competence is understood as a combination of knowledge, skills and attitudes appropriate to the situation.

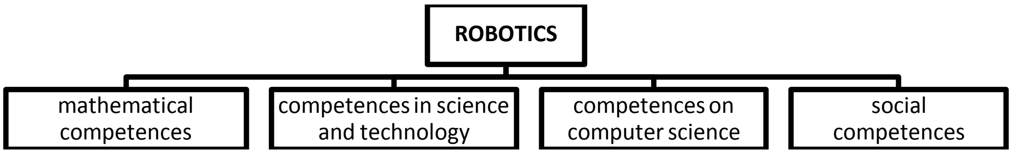

Figure 1. Robotics and training on key competences
Source: Own work

Such workshops can develop in students the skills described in the core curriculum for primary school.

Learners, taught in Polish primary schools based on the applicable core curriculum of 2014, as early as the first stage of education can be taught skills included in the curriculum during the course of robotics, when designing their own robotic machine or vehicle.

Learners at the first educational stage acquire in particular the skills presented in Table 2. For selected learning content examples are provided of activities of the learner when developing and programming the robot. A visual robot programming environment can be installed and run on a computer or tablet.

Table 2. Teaching content of early childhood education
and examples of activities associated with the construction and programming of robots

<table>
<tr><th>The area of early childhood education</th><th colspan="2">Didactic content
- specific requirements</th><th>Examples of activities related to construction and programming (in the graphical environment) of robots</th></tr>
<tr><td rowspan="5">Mathematical education</td><td colspan="3">The learner</td></tr>
<tr><td colspan="2">writes digits and reads numbers in the range of 1000; understands the decimal positioning system;</td><td>write the time in seconds of engine operation or the number of engine rotations;</td></tr>
<tr><td colspan="2">compares any two numbers in the range of 1000 (using the characters <, >, =);</td><td>writes command execution conditions: more than, less than;</td></tr>
<tr><td colspan="2">measures and writes down the result of the measurement of length, width and height of objects and distances; uses units: millimetre, centimetre, metre;</td><td>determines the distance to be covered by the mobile robot; determines (estimates) the distance between the robot and obstacle;</td></tr>
<tr><td colspan="2">specifies the location of objects relative to the chosen object, using the terms: up, down, forward, backward, right, left, and combinations thereof.</td><td>determines the position and direction of motion of a mobile robot.</td></tr>
<tr><td rowspan="4">Computer classes</td><td colspan="3">The learner</td></tr>
<tr><td colspan="2">uses a computer on a basic skills level;</td><td>launches (runs) the graphical environment of programming of robot; saves the created program</td></tr>
<tr><td colspan="2">uses the selected programs (...), developing her/his interest;</td><td>uses, during her/his work, graphical robot programming environment;</td></tr>
<tr><td colspan="2">searches for information and uses it: plays (runs) animations and multimedia presentations.</td><td>plays (runs) animations and instructional videos placed inside projects in a graphical environment for robot programming.</td></tr>
<tr><td rowspan="6">Design
and technology classes</td><td colspan="3">The learner</td></tr>
<tr><td colspan="2">knows technical environment to such an extent that is familiar with the ways of production of everyday objects ("how was it made?");</td><td>constructs models of everyday objects (e.g. vehicles);</td></tr>
<tr><td rowspan="3">carries out activities along the “route” from the formation of objects from an idea to a product</td><td>presents ideas of technical solutions: plans new activities, selects suitable materials;</td><td>constructs models of machinery and vehicles; plans stages of work;</td></tr>
<tr><td>understands the need to organize technical action: individual and team work;</td><td>works in a team (2-4 students);</td></tr>
<tr><td>has the skills: measuring a required amount of material, assembling of plastic models, using simple instructions and drawing diagrams;</td><td>builds on the basis of instructions (series of pictures, schematic drawings) a vehicle or machine, including collecting the necessary elements (components, motors, sensors);</td></tr>
<tr><td colspan="2">cares about her/his safety and that of others: maintains tidiness and order around her/him in the workplace; cleans up after herself/himself and helps others maintain tidiness.</td><td>tidies up his workplace, sorts parts needed to build a robot.</td></tr>
</table>

Source: Own work

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What is equally important is the fact that robotics classes can be associated with the implementation of group educational projects (short or long term, inherently interdisciplinary), which are recommended as a form of work with students already at primary school level and required – at high school level.

The Council for the Informatization of Education at the Ministry of National Education (Poland), on 18 June 2015, presented the proposed changes to the current IT core curriculum. The Council's proposal has been made available on the Ministry website for consultation (until the end of October 2015).

The Council adopted the final form of the proposal at its meeting on 10 December 2015. Account was taken of all the opinions submitted during the consultation and reported on several meetings with teachers in Poland and meetings of experts, as well as abroad.

According to the Council for the Informatization of Education, one of the goals of universal information education is to improve the relevance and importance of computer science as an independent discipline as perceived by students and society (...). Early contact at school with computer science and programming should give students the idea of the richness of this field and its applications in other subjects and areas, and to stimulate interest and motivate the choice of future education and a future career in this direction.

Members of the Council are proposing to include, in specific requirements for computer classes for the first stage of general education (among other things), certain provisions in favour of robotics. For example, the proposal states that the student:

- creates a command (command sequence) for a specific plan of action and to achieve the objective; in particular, performs or programmes these commands in a computer application;
- programmes visually simple situations (...) according to his/her own ideas and the ideas developed together with other students, other (Council for the Informatization of Education 2015)

The proposals of the Council for Informatization of Education confirm the advisability of the use of robots (more broadly: creative toys) in the teaching process.

Legal documents on Robotic and STEM education at school include: Ukrainian decree No 188 of 29.02.2016 on the establishment of a working group for the implementation of STEM-education in Ukraine; Regulation of the Ministry of Education and Science of Ukraine of July 2, 2016 № 759 on carrying out experimental work at municipal educational institutions"; Educational Complex № 141 "Educational Resources and Technological Training" in Kyiv (pre-school - school degree - specialized School second degree with in-depth study of foreign languages and information technologies - technological Lyceum) "for 2016-2021 years, with approved experimental work on "Creation and testing of methodology system of teaching the basics of robotics as part of STEM-education." c. The website of the Institute of Modernization of Educational Content, STEM-education Department, lists only the following documents:

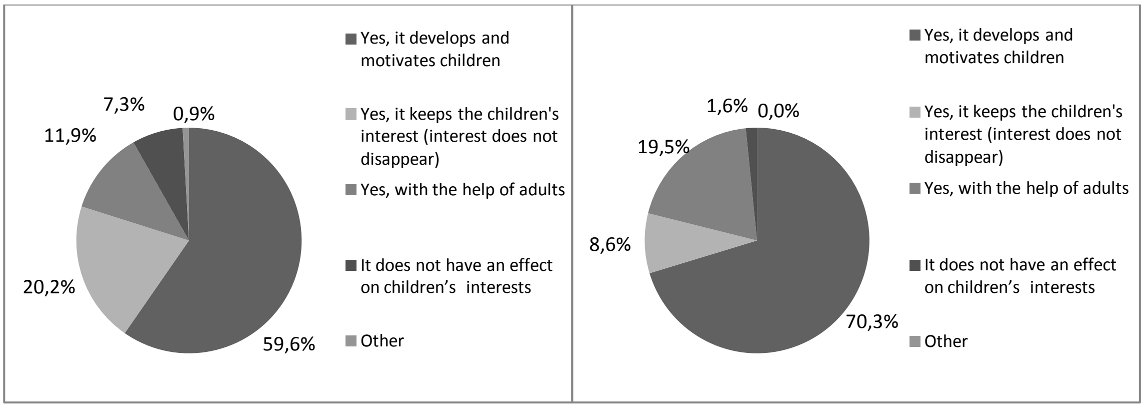
Laws of Ukraine
On education
On preschool education
On general secondary education
On school education
On higher education
On innovation
On scientific and technical activity
Age of children at primary school in Poland – 6-12 or 7-13 years old. In Ukraine: 6-10 or 7-11.

2.2 Methodology and Selected Results

The study was carried out with the participation of 91 primary school teachers and future teachers in the province of Silesia and the University of Silesia Poland and Ukraine and Borys Grinchenko Kiyv University. The survey contained 15 questions about the pedagogical research "Robotics and children." The study was carried out to determine the needs of modern education to introduce the basics of robotics in the educational process of primary school.

2.2.1 Question 1. Do you think that it is interesting for Children to create a Robot by Themselves?

The respondents were allowed to choose one answer out of the answers as shown in Figure 2 (for Poland and Ukraine, respectively); they were also able to provide their own – by selecting "Other".



(a) Poland (b) Ukraine

Figure 2. Respondents' answers to the question "Is it interesting for children to create a robot by themselves?" (a) Poland (b) Ukraine
Source: Own work

Almost 80% of the respondents in Poland and almost 79% of the respondents in Ukraine thought that development, motivation to work and continuing interest of children were possible benefits to be derived from building robots. The first two answers are in a different ratio in relation to each other: 3:1 (Poland), 8:1 (Ukraine).

2.2.2 Question 2. What part of the Foundations (bases) of Robotics should be offered in Primary School?

In this question respondents were allowed to choose one or more from the following options (Figure 3):
A. Design; B. Construction; C. Algorithmization; D. Programming.

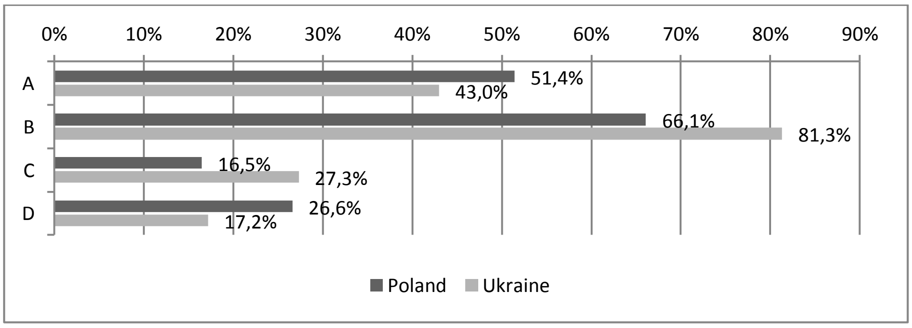


Figure 3. Respondents' answers to the question "What part of the foundations (bases) of robotics should be offered in primary school?"
Source: own work

Both in Poland (over 66%) and Ukraine (over 81%), respondents pointed to construction, as the activity associated with the creation of robots, which – according to them – is the best for elementary school pupils.

2.2.3 Question 3. What Competencies Useful in Life can be developed in Children while teaching the Basics of Robotics?

Respondents were allowed to choose multiple answers.
A. The skill of formulating one's own goals.
B. The skill of (the ability to) independent learning.
C. Solving specific problems.
D. Ability to work in groups, sharing experiences.
E. Ability to see the problem, find ways to solve it, generating ideas, planning and organizing activities
F. Forming a type of thinking is useful for solving practical problems unconventional (critical thinking)
G. Taking responsibility.
H. Use of ICT.
I. The ability to reflect (the process of self-examination of activities and their results)

Almost half of the respondents in Poland indicated the skills (the ability to) independent learning (B) and on the ability to work in groups, sharing experiences (D) as a useful life competencies formed during the course of robotics.

Among Ukrainian respondents: almost 70% of respondents indicated the ability to work in groups, sharing experiences (D); almost 58% – on the formation of the type of thinking is useful for solving practical problems unconventional (F) and almost every other respondent – the ability to formulate their own goals (A). The results of this question are presented in Table 3.

Table 3. Respondents' answers to the question "What competencies useful in life can be developed in children while teaching the basics of robotics?"

	A	B	C	D	E	F	G	H	I
Poland	44,0%	47,7%	45,9%	48,6%	37,6%	31,2%	32,1%	17,4%	21,1%
Ukraine	49,2%	45,3%	32,8%	69,5%	46,9%	57,8%	33,6%	37,5%	32,0%

Source: Own work

2.2.4 Question 4. What Professional Competence can be developed in Children while learning the Basics of Robotics?

Respondents were allowed to choose more than one answer, and also to specify their own answer – by selecting "Other".

A. The personal ability to create models of objects (construction).
B. Understanding basic concepts of algorithms (creating algorithms for different performers).
C. Programming skills (the command to execute, written in a specific programming language).
D. Increase interest in science, the directions of technical (engineering) and informatics.
E. Ability (Skills) to work with computer.
F. Ability (Skills) to work with the use of ICT tools while performing complex tasks.
G. Ability (Skills) to logical thinking.

The results of this question are shown in Table 4.

Table 4. Respondents' answers to the question "What professional competence can be developed in children while learning the basics of robotics?"

	A	B	C	D	E	F	G
Poland	64,2%	40,4%	48,6%	45,0%	53,2%	21,1%	45,9%
Ukraine	80,5%	46,9%	46,9%	53,9%	48,4%	44,5%	75,0%

Source: Own work

Respondents in Poland preferred the option: the personal ability to create models of objects (A) as a substantive competence shaped by the science of robotics.

More than half of the respondents indicated the ability to work with a computer (E) as a substantive competence shaped by science, robotics, but only every fifth respondent combined robotics with the ability to work with the use of ICT tools (ICT) while performing complex tasks (F).

The respondents in Ukraine (as in Poland) most often preferred the option: the personal ability to create models of objects (A) as a substantive competence shaped by science, robotics (more than 80% of the responses, more than 16 percentage points more than in Poland).

2.2.5 Question 5. What Twenty-First Century Skills can be developed in Children while learning the Basics of Robotics?

Respondents were allowed to choose more than one answer; they were also allowed to specify their own answer – by selecting "Other".

A. Solving real problems.
B. Critical systems thinking – thinking we use when solving practical problems during the tests (creative thinking).
C. Communication skills.
D. Effective cooperation.
E. Teamwork skills.
F. Quick search and data processing.

G. Ability to take responsibility.
H. Being active.

The results of this question are presented in Table 5.

Table 5. Respondents' answers to the question "What twenty-first century skills can be developed in children while learning the basics of robotics?"

	A	B	C	D	E	F	G	H
Poland	35,8%	60,6%	42,2%	48,6%	48,6%	39,4%	31,2%	36,7%
Ukraine	32,8%	63,3%	51,6%	46,9%	53,9%	39,8%	44,5%	18,0%

Source: Own work

For the most part (more than 60% of the responses in Poland and Ukraine), the respondents pointed to thinking used when solving practical problems during the tests (B) as a twenty-first century skill that can be developed in children while learning the basics of robotics.

Almost half of the respondents in Poland chose effective collaboration (D) and teamwork (E).

More than half of the respondents in the Ukraine pointed to teamwork (E) and communication skills (C).

2.2.6 Question 6. Is it Necessary to teach children what they like?

In this question the respondents were able to choose one answer from the following (Figure 4):

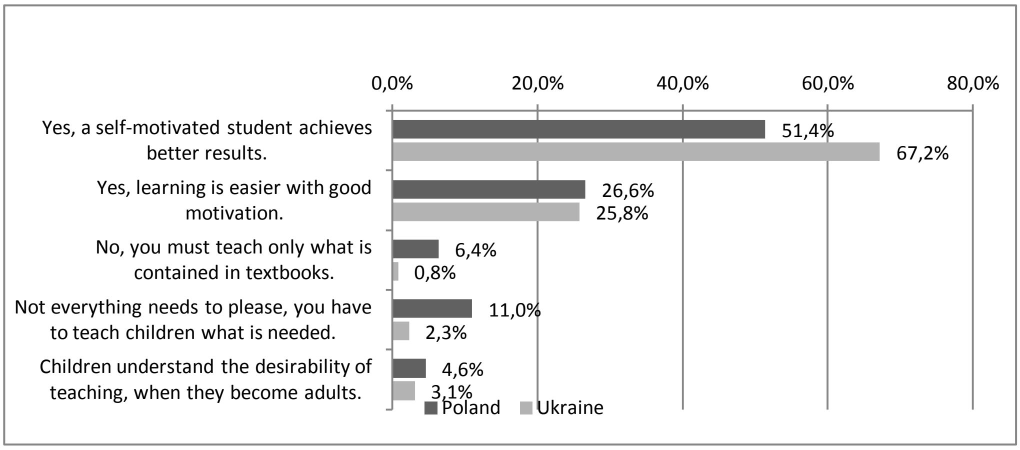


Figure 4. Respondents' answers to the question "Is it necessary to teach children what they like?"
Source: Own work

As can be seen, more than half of the respondents in Poland and more than 67% in Ukraine appreciate the role of motivation to learn.

After analysing the survey results we found that both active and future teachers in primary schools in Poland and Ukraine are aware of the need for implementing robotics in order to increase students' motivation. Competencies which are formed when implementing STEM education have been identified. In Ukraine there is an urgent need to train specialists who will be able to make learning with robots useful and effective, and make it a tool aimed at popularizing STEM education.

3. CONCLUSION

The article presents issues related to STEM education; it is emphasized that the need to prepare students with twenty-first-century skills through STEM-related teaching is strong, especially at the elementary level. The authors stress that workshops, using kits to build and program robots, are a modern form of interdisciplinary education of children and youth. The rationale for conducting such activities in schools is found in the European reference framework in the context of training of key competences. Classes in robotics – properly taught – will have an impact on the development of mathematical literacy and scientific-technical information and social competences. At the same time, competence is understood to mean a combination of knowledge, skills and attitudes appropriate to the situation. The results of survey conducted in Poland and Ukraine among in-service teachers and prospective teachers show that more than 50% respondents understand the important role of the STEM education and the necessity to introduce it the elementary level of education by workshops and other activities. These classes and other STEM education activities could provide successful development of twenty-first-century skills, in particularly key competences. Simultaneously, still open is the question concerning the comprehensive STEM education of prospective teachers pursuing pedagogical programmes, in particular in the specialization of early education

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TOWARDS THE SUCCESSFUL INTEGRATION OF DESIGN THINKING IN INDUSTRIAL DESIGN EDUCATION

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ABSTRACT

This paper narrates a case study on design thinking based education work in an industrial design honours program. Student projects were developed in a multi-disciplinary setting across a Computing and Engineering faculty that allowed promoting technologically and user driven innovation strategies. A renewed culture and environment for Industrial Design students emphasized seeking functionality and fidelity, user and society value over beauty and form factors alone. The pedagogical approach sought to determine the new industrial products reality with an increasing contribution by design thinking and its associated methodologies that are currently advancing typical Industrial Design. In conclusion, the authors propose a number of reflections as recommendations, which may be useful for educational institutions contemplating similar curriculum makeovers to their design degrees.

KEYWORDS

Industrial Design, HCI, Design Thinking, and Design Education

1. INTRODUCTION

Industrial Design (ID) was traditionally thought of as a paradigm of constructing, designing and mass production of physical products. However, currently the discipline from an educational viewpoint finds itself in a dilemma with the growth of advanced manufacturing, technological advancements and the need for a maker culture. In Australia this dilemma is further aggravated as industrial design is still greatly geared towards industrial era manufacturing. Importantly, manufacturing was a traditional stronghold of national economy and development in the country. However, studies show that sector has fallen progressively. Australian Bureau of Statistics (Kryger, 2014) shows a more complete decline in 40 years to lows of 6.8% GDP to the period 2012-13. The commercial challenges to the discipline have also mirrored in the various educational establishments both within and external to Australia.

The lack of clarity, vision and direction of ID Education in the current day and age has been discussed by many practitioners and researchers; Donald Norman in particular. Norman has pointed out (Norman, 2010) regarding the challenges of the current times facing Industrial Design Education. He manifests a clear requirement of Design to be treated as a multidisciplinary domain with borrowings from Science, Psychology, Computing and Engineering. According to Norman altering the mindset of educators and the students is difficult and requires changes to the pedagogical setup from the bottom up and designers and design students are having to engage in the online development of skills which are traditionally not provided in design curricula. The positioning of Design Education as a research-led endeavor has also been fraught with various obstacles, with designers unsure of how best to incorporate science and empirical research in their projects. The reasons of the uncertainty and nature of stalled revamps for Industrial Design programs has been discussed in research (Bronet et al., 2003), industry and education; including: hosted by and orphaned into larger non-technical schools (such as Architecture and Arts), disassociation with science and data, over-indulgence in aesthetics and sketching, dissemination through non-literary and non-conventional forms, etc. As a consequence, several education programs are initiating curriculum changes to better suit them to the growing demands of today’s digital and advanced world.

At the Western Sydney University, within the School of Computing and Engineering, Industrial Design is one of the key undergraduate programs. The School considers the Industrial Design program to play a central role binding the other disciplines of Engineering, Computing, Construction and Mathematics. Fresh entrants to the Industrial Design program usually complete a major in Design and Technology in high school spread across their final years. To date the focus of this major is primarily on aesthetics, hand crafting of products and otherwise, drawing and art based skills. Therefore the students upon entry to the Industrial Design program are unable to rapidly address to the aspects of problem-based design, maker culture or quick and dirty prototyping. This is in complete contrast to children in primary school who are learning programming from very young ages (Mitchell, 2015). In order to understand the assimilation of our students to the new way of thinking and approaching Industrial Design we have begun our efforts of a change in ideology with a top to bottom approach starting with the more mature final year students. We have trialed an induction of a design thinking approach and its associated aspects of user-centered design, interactive technology and maker culture in the 4th year honours/thesis projects.

Design thinking merged with Human Computer Interaction (Ciolfi and Cooke, 2006) - i.e. innovation driven by the design of interactive technology; can perhaps provide the required thrust to the rather stale traditional ID education practiced in Australia. In recent years design thinking has created tremendous awareness and its popularity has expanded across several industries and domains such as business and management (Dunne and Martin, 2006), social innovation (Dunne and Martin, 2006, Brown and Wyatt, 2015). The intertwining of HCI and design thinking has been of interest in the research community particularly through the notion of research through design (Zimmerman et al., 2007), where interaction designers are provided with tools to project and verify their research. Many researchers strongly support and encourage the free mingling of the two disciplines of HCI and ID (Overbeeke and Hummels, 2012) with many HCI researchers terming Design led characteristics (such as sustainability, ethics, entrepreneurship, social responsibility, etc.) as a key pillar of HCI research (the others being technology, cognition and ethnography) (Blevis et al., 2015). Gradually the two disciplines are converging particularly as HCI researchers contemplate societal aspects and designers seek to adopt technological developments (Overbeeke and Hummels, 2012). In addition design thinking and HCI are seamlessly beginning to co-exist through methodologies such as user-centered design and rapid prototyping in particular across HCI curricula (Culén and Følstad, 2014). However we do not find a well-documented account in literature of design thinking based approach through Industrial Design programs as we intended to follow to reinvigorate our ID curriculum. In sum, in our pedagogical approach we sought to determine the contribution of design thinking towards advancing typical Industrial Design final year projects. In this paper we present a case study based account of two fourth year undergraduate honours projects; co-supervised by two of the authors where we witnessed a marriage of HCI led innovation surge and design thinking towards industrial design research. We conclude with reflections and recommendations, which may be useful for educational institutions contemplating similar curriculum makeovers to their design degrees.

1.1 Our Pedagogical Approach

At the Western Sydney University, Blooms Taxonomy (Bloom, 1971) is dominant throughout the institution with a variety of influences according to discipline. For Industrial Design, it represents a way to connect and have a common understanding with other disciplines within the School and university. It brings about experimentation and playing with ideas as a way of continued prototyping and iteration; reminiscent of the design thinking based DIY, interaction and maker culture (Lindtner et al., 2014).

The Industrial Design undergraduate degree at the Western Sydney University is offered as a four-year course with the final year conducted as a year long honours/thesis project. It is worth mentioning that only students who attain an average grade of credit or above (> 65%) are invited to the honours program and hence are the best performing students of the course. The honours program is structured as a 70-credit point embedded degree where students complete a design research project under the supervision of an academic. The assessment criteria are based around the form and function of a tangible and physical product (model), which forms the main deliverable of the program besides a thesis document. All assessments are marked by independent examiners in a peer review format. Students enrolled in the honours program (class strength typically ranges from 10-12 in number) convene once a week (28 times in a year spread over two 14 week semesters) for a 2 hour practical lecture followed by a flexible and 4 hour workshop and supervision block. It is not uncommon for students to meet with their supervisors outside the timetabled hours. In the case of the student projects presented and discussed in this paper the first two authors functioned as co-supervisors whereas additionally the first author was the honours coordinator and the second author the director of program in ID. Therefore it was possible to transmit the required design thinking and HCI innovation skills both in breadth (class discussions) and depth (individual supervisory meetings) across the two projects by the two member supervisory panel.

The following were the main elements of supervision; advice and training provided to the students that would provide the required level of and support the integration of design thinking and HCI skills:

1. Facilitating User-centered design and acquiring user empathy through:

(a) Training on conducting participatory design and brainstorming work- shops

(b) Formulation of research methodology via IDEO Cards (Ideo, 2003)

(c) Mentoring on how to conduct focus groups, surveys and questionnaires

(d) Guidance on Qualitative Data Analysis using methods such as content analysis and grounded theory

(e) Extensive hands on training on applying for Research Ethics Approvals

2. Inculcate a culture of Quick and Dirty Prototyping by:

(a) Encouraging fast hand sketching of concepts and reduce reliance on rendering and rendered images

(b) Exploring various materials for visualisation of prototypes (foam, cardboard, light timber and paper)

(c) Reducing the tendency of over-obsession with one concept through 2a) and 2b)

3. Promote High fidelity and high functionality by:

(a) Exposure and awareness to Arduino and its sensory possibilities amongst other hardware programming software using both Arduino (script) and Ardublock (visual) integrated development environments (IDE)

(b) Instilling a hacking mentality by utilising open source material (off the shelf artefacts, tools, code exemplars from online resources, etc.)

4. Iterative Concept Design and Research Process (a) where possible; iterate through both concept design and user feedback elicitation to arrive at a set of design guidelines and/or design concepts for further implementation.

In summary, our supervision, advice and training framework to our students was primarily based on a design thinking approach including hands-on and action research based approach; i.e. quick and dirty prototyping, fast hand sketching, rapid prototyping, participatory design and iterative user involvement.

2. CASE: INDUSTRIAL DESIGN HONOURS PROJECT

In this section we document our experiences of supervising and running two separate honours projects where we inculcated an HCI led and design thinking based methodology. The approach, design methodology and supervision arrangement of both projects was similar hence we present both endeavours collectively; only differentiated over our insights acquired throughout each of the steps in the design thinking process. Both projects were supported and drafted in consultation with a key industrial partner in InfaSecure; based in Penrith, Australia. The company is primarily concerned with the manufacture of child restraint seats (CRS) of all types and their associated accessories. In addition the company is involved in the design and innovation of interactive toys for children, in particular for education and entertainment. The initial drafting of the research problem for both projects was primarily sourced through secondary research and extensive discussions with the marketing, R&D and design team of the company. The first project aimed to reduce driver distraction by leveraging the design of existing child restraint systems so as to inform the driver in a salient, subtle and discreet manner the well being of their child. The second project aimed to promote learning through play by investigating the design of sports toys that could promote physical activity and social responsiveness. Although the industry partner had a key role to play in the design process (elements of which we elaborate on shortly), the research investigation was carried out by the two Industrial Design students in house under the supervision of the first two authors. Both projects followed an iterative and user centered approach as their design process with elements from design thinking sprinkled throughout. This process is summarised in a flow chart (See Figure 1). Many of the intermediate steps and techniques were driven by methods from the IDEO method cards. The design space was initially explored and funneled through semantic maps/concept maps/collages. Thereafter, based on industry feedback and secondary

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research a first set of initial design guidelines were drafted. Using the keywords expressed in the maps and the set of design guidelines the students were then encouraged to quickly initiate hand-drawn concept sketches of possible product designs - typically ranging between at least 3-5 concepts per key design feature. In a typical brainstorming fashion students were advised not to critique their design ideas at this juncture.

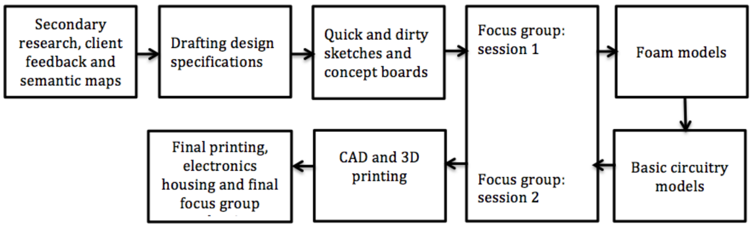

Figure 1. Flow chart of design process

2.1 Low and Hi-Fidelity Prototyping

Prior to obtaining feedback on their concepts from users, a pre-selection of a set of concepts was achieved through the Questions Options and Criteria Technique (QoC) (Maclean et al., 1991). The outlining of design rationale allowed the students to explore a wide variety of concepts and ultimately iterate through them. Thereafter concept boards with rendered sketches were created and evaluated with users (in this case parents in both projects). By this time the necessary ethics approvals had been attained to conduct primary research with human participants. We strongly recommended the students to acquire initial feedback even by using concept boards (See Figure 2). The main aim was to elicit user feedback and user insights as early in the design process as possible. Hence focus groups were conducted at the site of the industrial partner where they invited key customers (parents) from their product launch Facebook group. Since this was the first instance when the team (the students in particular) where engaging with the user; the initial phase of each focus group aimed to conduct user requirements generation; i.e. what are the current usage patterns of the concerned devices (Child restraint systems or educational toys), what are the purchasing requirements, what are the problems faced with the existing devices and are there are any wish lists, etc. The second phase of the focus group concentrated on discussing the concepts via the concept boards. Qualitative Data was recorded and insights gained contributed towards the modification of design concepts but also allowed the research team to rank the concepts in terms of preference. In the subsequent design phase a more hands on approach was followed and the phase of prototyping commenced. The students incorporated bodystorming (Oulasvirta et al., 2003) with anthropometric analysis (Kroemer et al., 2001) and foam modeling to envision their intended prototypes and the environment they expected the products to be deployed in. In the child restraint project a dummy wooden interior of a car was crafted to and foam models were extensively created to allow a tangible representation of the design ideas (See Figure 3).

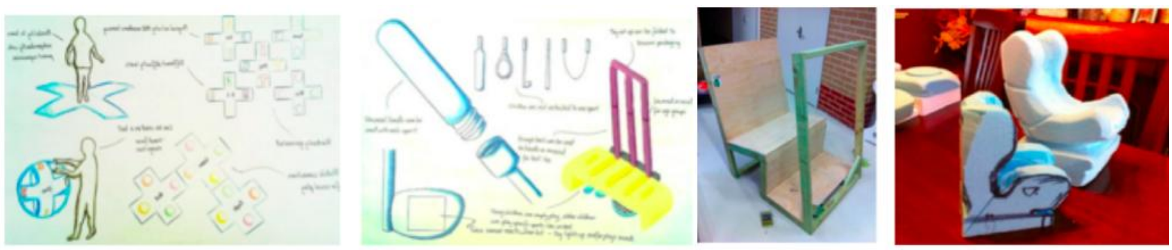

Figure 2. Concept Boards and Foam Models

In the second half of the project the students began to concentrate on developing their prototyping skills using Arduino. Both students did not have a strong programming background so the initial learning activities were built around the visual software ArduBlock with eventual transitions to using the standard Arduino IDE. In addition, the supervisory team and the students co-created and coded several off the shelf examples together to gain a sense of programming with electronics. Deliberately we did not force the students to envision the integration of the electronics into their final product but rather persuaded them to play around and experiment with their circuits. This led to the creation of many un-cased and breadboard based circuits, which proved to be very useful for demonstration purposes (See Figure 3). Such circuits and demos were quick to assemble and dismantle which allowed the students to persist with their iterative design process and consequently showcase not one but several prototypes. The current phase was ripe for further user intervention and a second round of focus groups was conducted where the more tangible prototypes were displayed (foam models and circuit demonstrations). The focus groups were again conducted at the site of the Industrial partner with the relevant target group and were utilised to further hone in on the final design concept. The final model of the child restraint seat was a subtle awareness system that would transmit the environmental temperature of the child through a change in color of LED strips (blue indicating a cool ambience; red indicating hot, etc.). In the learning through play project a toy cricket bat was designed that would give force/audio/visual feedback on the quality of the shot by the child.

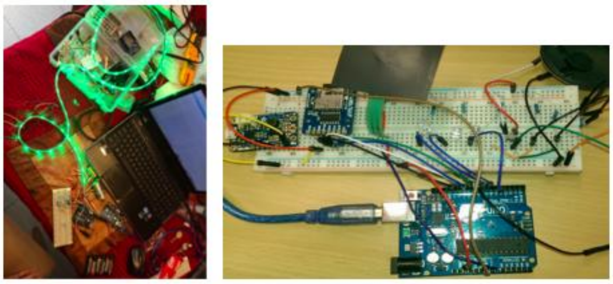

Figure 3. Arduino open circuits

Utilising insights gained from the second round of user evaluations a final design concept was converged to and the phase of final prototyping commenced. Key decisions at this iteration revolved around material analysis, structural requirements, housing of electrical components and resolution of finalised look and feel/aesthetics. Detailed component sketching led to the creation of Initial Computer Aided Design (CAD) models (of a reduced scale initially) which were then rapid prototyped (See Figure 4). The students had a wide range of 3D printers at their disposal, which allowed for customised 3D printing; such as low cost prints for initial CAD models. The basic CAD models enabled trying out casing and the layout of the electronics (See Figure 4). The final CAD models were then prototyped using high quality 3D printers (Objet) and the electronic components were subsequently integrated through soldering (See Figure 4). Final round of user evaluations with the developed models was conducted as focus groups to determine the success of the prototypes and identify future design recommendations. As with the other focus groups these concluding sessions were also conducted at the site of the industrial partner.

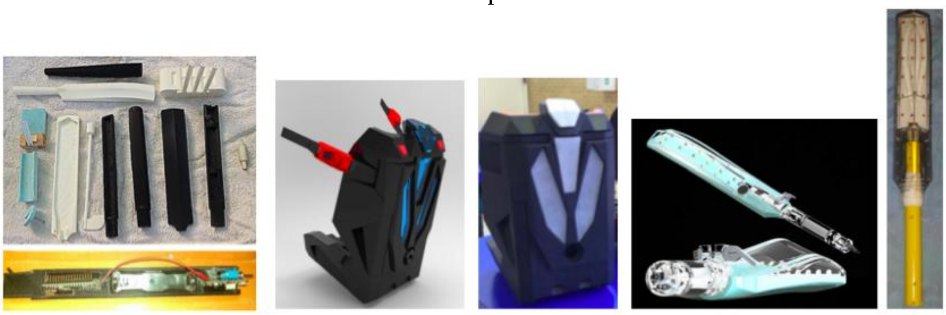

Figure 4. L to R: intermediate 3D printouts and electronic casings - toy bat only; Final renderings and images of completed product - both products

3. RESULTS AND REFLECTIONS

The discussed design process in Industrial Design projects is now reflected upon and reflections are presented which are of value to other Industrial Design academics and practitioners. We followed a distinctly radical design approach to conventional Industrial Design projects as conventionally executed in our faculty. There was a clear preference and emphasis on striving for functionality over aesthetics and other form based factors. Aesthetics is an important principle but one which we encouraged students to pursue towards the end of their project. We collectively infused creative intelligence into the projects as a joint design team (industry partner, us as supervisors, non ID academics as experts and the students as designers); providing further evidence that design thinking is best applied within a multidisciplinary team (Seidel and Fixson, 2013). We generally achieved positive and encouraging outcomes through the application of design thinking in our ID program. Additional reflections and experiences with regards to the design process are outlined hereunder.

3.1 Human Ethics

Being based in Australia our faculty is bounded by the requirements of ethics approvals for any research involving human participants. The process involves red-tape and can be a burden for undergraduate students. In this particular instance we as supervisors facilitated the students so that their ethics approval was attained early on in the project. Both of our projects involved preschool children as one of the key stakeholders; however obtaining ethics approval to conduct research with children in our institute is relatively complex and would have been difficult to resolve within the timeline of the projects. Alternatively all research was conducted with parents as the other half of the target market. We are of the opinion that ethics is an issue of being professional rather than documenting several pages with methodological details. A middle ground will be ideal for undergraduate students especially design students where involving the user at every iteration is imperative. We are in discussions with our Human Ethics once with the aim to explore and finalise a possible program ethics approval spanning the entire honours course structure.

3.2 Quality of Design Process and of End Product

In general the students appreciated the design process and were positive about the focus on hands on activities that provided them with quick and tangible results. Traditionally the ID program at our institute instills a great deal of emphasis on sketching hence the students were well equipped with the required drawing abilities. However their initial tendencies were to pursue finished and rendered sketches; it was only after cajoling from the supervisory team that they felt more comfortable with free hand sketching. The IDEO Method cards allowed a wide array of methodological possibilities and relevance of a method to their project was easy to establish. Involving the user at every iteration was a slightly unknown proposition to the students (a known tendency in ID students (Eroglu et al., 2013)) and we encouraged the students in holding mock focus groups to practice and finalise their study protocol. In addition, both students were comfortable with hands on activities, prototyping and CAD modelling. The students were constantly reminded that evaluations could also be conducted with unfinished products or rough prototypes. Evaluation with quick and dirty prototypes (concept boards, foam models and open Arduino circuits) led to rich and engaging feedback from the target user group, which were rapidly absorbed by the students to their design concepts. The students were also content with delaying the CAD development towards the end until design choices were finalised. During the user feedback elicitation stages the students were not attached or obsessed with one concept; ultimately allowing them to readily and rationally process design modifications in an unbiased manner. By enhancing the decision-making opportunities for the students in the design process we noticed that they developed a sense of ownership and responsibility with regards to the project.

The outcomes of the project were also successfully evaluated from both an academic and commercial perspective, which augurs well for the continuation of our recommended design process to upcoming honours students. Both projects attained a Distinction mark overall (> 80%) which lends some credibility to the quality of work given that the project outcomes were marked by independent examiners and experts. Furthermore the project outcomes have already been published in a HCI conference with the reviewers specifically appreciating the marriage of HCI into Industrial Design. Our industry partner is also working on the further development of the concept emerging from the child restraint project. We are also in negotiations with the legal department at our institute to pursue a patent of the toy cricket bat and its associated technology. The revised content was not only appreciated by the two students that we supervised but also by the entire honours group (on average 10 students per year) as indicated by the student feedback on unit (see Figure 5). The average ratings across a 2 year period of implementing our new vision to the honours program (2013-2015) were a distinct improvement to 2012 which was prior to introducing design thinking based changes to the program.

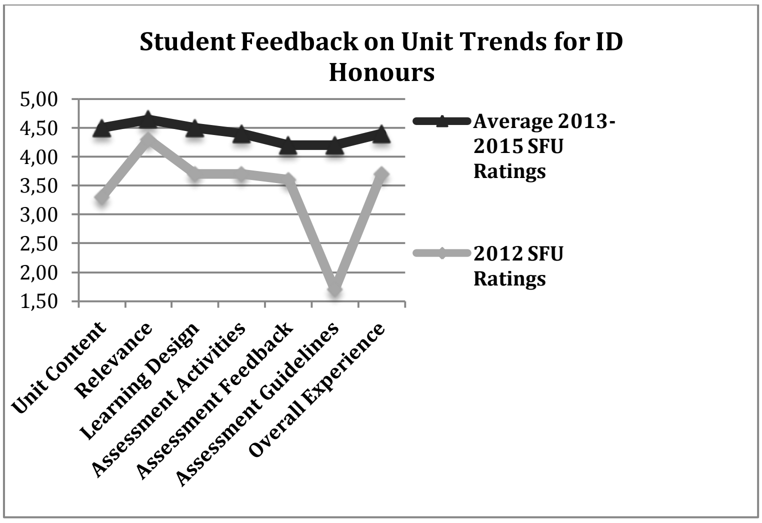

Figure 5. SFU Trends for ID Honours comparing pre & post design thinking based curriculum (max best rating is 5)

3.3 Electronics and HCI led Technology Driven Innovation

In order to develop functional products we have explored Arduino interfaces as the tool of choice. Arduino is commonly utilised as a tool for tangible and embedded prototyping in design projects offering design students a physical representation of their programming efforts (Alers and Hu, 2009). Our students had limited experience with programming hence there was a learning curve associated with their development. We gradually introduced them to the world of Arduino and hardware programming using visual tools such as ArduBlock with eventual transitions to incremental open circuits before the eventual design of the casings and housings of the electrical components. Arduino is licensed under a Creative Commons agreement hence there are sufficient open source materials which can be brought to the fore and under usage. In order to fully appreciate the potential of Arduino as an input/output interfacing platform we also introduced the students to the areas of Multimodal and Tangible interaction from HCI. We noticed the students were highly adept with any hands on activities associated with electronics programming such as the circuitry design and soldering but required assistance with coding. In the future we expect incoming honours students to be more attuned towards coding and programming because such skills are gradually finding their way in high school in Australia. The competency of technological development is already an integral component in other ID curricula around the world such as in Delft and Eindhoven (Hummels et al., 2011). In consideration of the above, we have introduced new units such as ‘Programming for Designers’ and ‘Tangible Interaction’ in our revised ID curriculum where such skills would allow students to create complex products and interactions.

3.4 Importance of the Environment

The setting of our ID faculty in a multidisciplinary school and environment largely facilitated our efforts in introducing design thinking in the honours stream. Positioned amongst the engineering and computing faculties not only did we have a wide array of 3D printers and laser cutters but also software and engineering tools (including Arduino sensors and electronics), etc. Several key design decisions pertaining to the structural integrity and electronics housing were made in close consultation with academic experts from the engineering faculty. The importance of the industry partner must also be acknowledged in the entire design process. Not only did the industry partner provide testing facilities and access to the target market but the drive to create a real life application was a source of motivation for the students.

4. CONCLUSION

There are several outcomes made in this paper that can contribute to others wanting to do a makeover of their design programs. For one, we present the key role of integrating HCI with industrial design education since

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the latter is not longer measured by its functional and aesthetic attributes only. Second, we claim the need to conceive the discipline of design as a multi-disciplinary collaboration from different fields of expertise across both academic and non-academic/industrial sources. Third, it is possible to lead students by design thinking towards a more updated form of design practice in relatively short periods of time. Fourth, the co-authors recognized a way to facilitate modernization of their academic program while assisting customization of Bloom's Taxonomy for their course. Fifth, the importance of empowering students by increasing their project ownership through a iterative process from quick and dirty, low fidelity to high-fidelity prototyping and making of final presentation and reference models. Further design research and discussion is needed to elaborate on how this contribution conforms towards a new taxonomy of transformative learning based on creative intelligence beyond traditional disciplinary skills.

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INTERNATIONAL STUDY TOURS: A KEY TO 21ST CENTURY ACADEMIC AND INDUSTRY EXCHANGES

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ABSTRACT

This paper is based on the retrospective reviews of the Information Systems study group who went on the international study tour to India to learn, network and collaborate with academics, students and industry professionals overseas. The paper addresses concerns of local Australian Science, Technology, Engineering and Mathematics recruiters and identifies how a well-planned educational study tours could in the future help graduates meet industry and recruiters' demands. It furthermore identifies that 21st century international business ventures and global partnerships require future graduates to not only be skillful in their professions but also be global citizens, know and understand different cultures, easily adapt to new environments, skillfully negotiate business deals, mindfully communicate and swiftly learn to apply and follow local rules, customs and regulations.

KEYWORDS

Educational study tours, international partnerships, collaborations with businesses, new learning models

1. INTRODUCTION

Over the last century a main disruptor of the educational content delivery was "the Internet". It revolutionized and changed content storage, information searching, data dissemination and data analysis. Years ago primary sources of data gathering, learning and studying were the physical libraries and lecture halls. Currently, in addition to the formal knowledge delivery, information is globally available and searchable via the online databases and is available in multiple formats such as video, print and simulations. Information is passed instantaneously, just in time. This trend has opened new opportunities for global education and collaborations where data is available on a demand, just in time. Aggregation of such data has given a rise to electronic delivery platforms and online courses.

Therefore, classroom style of teaching and lecturing these days is not equivalent to that of centuries ago. First changes have been seen with the uses of computers and PowerPoint slides. In more recent times there has been a trend to utilize online sources, make content available 27/4 and encourage instantaneous feedback and even run classes and degrees online.

It is important to take into the account that both face to face and electronic exchanges have their advantages which are not mutually exclusive. It is apparent that students of the 21st century are globally connected and they search for data via applications such as YouTube, network via Facebook and look for jobs via LinkedIn. Virtually, young generations are connected and easily exchange data via a cloud which gives rise to international exchanges, collaborations, partnerships as well as the international study and work opportunities. However, to successfully work, study and network internationally, skills of virtual world networking alone are not sufficient. Therefore, young generations need to ensure they have skills required not only to establish the virtual international relationships but also have skills that are required to apply for jobs in a different country, attend business meetings internationally or engaging in collaborative business venture with both local and international partners.

This research identifies that based on the current data available, recruiters often assess graduates based on both soft and hard skills criteria. In particular, it is noted that current graduates require improvements and the attention to interpersonal and communication skills, cultural alignment/values fit, emotional intelligence (including self-awareness, self-regulation, self-motivation), reasoning and problem-solving skills first, followed by academic results, work experience and finally technical skills (GCA, 2016). Furthermore, past studies also demonstrate that the future of the employment for technology based employees is going to require skills such as relationship management, customer service, strategic planning and contract negotiating (Australia's Digital Pulse, 2016). Dishman 2016, identifies that critical thinking and problem solving, attention to detail, communication skills written and spoken as well as interpersonal skills were found to be requiring improvements in many of the current graduates. Office of Chief Scientists, 2013 identifies the importance of active learning, critical thinking, complex and creative problem solving as key drivers for the future STEM (Science, Technology and Engineering) graduates and therefore require more attention. The main reason for this is that STEM careers are becoming global, multidisciplinary and require knowledge and skills in multiple domains. Furthermore, many STEM roles and tasks large organisations these days often outsource (Woods, 2007) which further supports a need for the graduates to have knowledge about the international engagements and collaborations.

This paper therefore addresses the gaps identified by the STEM recruiters and based on the retrospective analysis of the international study tour conducted by both students and staff, identifies how in the future current STEM graduates could learn skills required for the successful international engagements. Furthermore, it identifies how in the future international business – academic exchanges could be incorporated to both face to face and even online delivery modes, so that students can learn how to network, work and collaborate in the international settings.

2. REFLECTIVE REVIEWS: EXPERIENCES AND LESSONS LEARNED

This study therefore, addresses and via reflective reviews identifies the extent to which engagements with the industry representatives and the peers at the overseas universities could help assist delivery of cutting edge knowledge and help students gain a multicultural understanding of work and study internationally that in the future could allow students to gain a cutting edge advantage in their chosen careers.

A successful education in today's networked environments encompasses both electronic and face to face exchanges and collaborations. They are both seen as essential, when looking for jobs, conducting business meetings or establishing new ventures. Taking this into account, this paper through a retrospective reviews highlights the study tour experiences and opportunities. This study is based on the recount of six students and one staff member.

A group of final year Information Systems students and two staff members undertook a twelve day study tour to India, during which students had the opportunity to meet and network with world leaders in the fields that are closely aligned to students' majors and sub-majors, such as mobile computing, health informatics, networking and social analytics. During the tour, students also had the opportunity to hear about the cutting edge information systems innovations in a wide range of industries such as telecommunications, information technology operations, automobile industry, pharmaceutical production and food chain supply operations.

Being a part of the tour, the study group also visited three universities where students had the opportunity to meet, network, exchange experiences and collaborate with peers in India. Activities undertaken assisted students to establish new contacts, share skills and learn about study and business principles in different countries. In addition, local visits and hands on industry experiences during the tour were closely linked with the Indian local culture, international business ethics, customs and habits which further enhanced students' experiences and gave them a real feel for what it was like to work and study in India.

Experiences and knowledge gained as a part of the study tour were categorized. Furthermore, recounts were grouped and main lessons learned and experiences gained described. In addition, each recount recollection identifies how experiences like these could in future be incorporated into teaching practices, so that graduates' skills are enhanced and graduates could then be better equipped for the international collaborative partnerships and exchanges.

Based on the analyzed data and groupings of the students and staff recollections it was determined that international study tours like the one conducted can provide skills and give students the opportunity to:

- *Lean about the international engagements while establishing industry and peer networks*
- *Learn about the global markets and the importance of dedication to learn and excel*
- *Learn how culture, customs and specific local regulations may impact system implementations in multinational organizations*
- *Learn about the different cultures and their business trends through both face to face and online exchanges*

- **Lean about the international engagements while establishing industry and peer networks**

Having the opportunity to network with the industry leaders and learn about the skills that are essential for the success in the global markets in India gave the study tour group a chance to learn about work and commitments in an international business. The study tour team also learned about the information systems and how they are being utilized day to day by world class companies to meet real life business operations in various countries. Furthermore, the study tour group had the opportunity to learn about the global operations of multinational cooperation as well as the importance for young employees to be proactive, engage and be ready to tackle complex problems as well as proactively seek new leadership initiatives. Literature also supports that it is essential for the current graduates to engage in complex problem solving and analytical thinking, as they are a key for the future innovations and business operations (Dishman, 2016, Chief Scientists 2013).

The study group, while overseas also had the opportunity to network with local students. This gave them an insight into what it means to study in a different country, what expectations students are being faced with based on the local trends and also through comparisons identify trends that are commonly shared between both Australia and India. It was also apparent that it was not just the language that was different, but also local habits, culture and customs which need to be understood as they often guide the principles of studying and learning, class participation as well as impact traditions of business meetings and gatherings. For the study tour students, having an understanding of the local expectations and traditions allowed the group to easier understand commonalities and differences as well as prepare for the future interaction. For example, the study tour students are now aware that study content covered in the area of Information System in India and Australia at the universities is equivalent. However, in Australia students are required to plan their study journey themselves, attend classes and seek help when required, while in India in addition to the set classes, there are often also guided practice lessons that allow for the work to be monitored and checked continuously to ensure students are gaining sufficient practice and study time. In business settings however, students have learned that young employees in both India and Australia are equally required to be proactive, engage in new opportunities and actively seek new challenges themselves.

Consequently, the study tour students have learned that once they are ready to commence working in a global company they can be expected to travel overseas and collaborate with other companies. Knowing for example the Indian market, gives the study tour students a cutting edge advantage. If the study tour students were to travel to India for work in the future, they would now know local traditions, greetings and networking habits and additionally would be accustomed to warm hospitality that may often involve cultural events as a sign of a respect.

The study tour students have also had the opportunity to establish new networks and connections which have opened doors to future collaborations. This also supports the notion that cultural diversity is beneficial for inter-cultural study and work (Volet & Ang, 2012). Having the opportunity to engage in proactive interactions gave students the ability to place themselves within the overseas culture and adapt to local standards which ultimately gave them an advantage as they are now able to adapt more quickly to the new environments.

Furthermore, literature identifies that current graduates require a close fit to the ‘cultural alignment’. It is worth noting that 34.3% of companies identify this criteria as one of the most important when selecting suitable employees (GCA, 2016). Therefore, exposure to the opportunities that allow students to be involved within different cultures and network with peers, academics and employees allows them to quickly adapt to the new environment. The study tour experience allowed students to expand networks, learn how to form them and identify future potentials.

- **Learn about the global markets and the importance of dedication to learn and excel**

The study tour experience gave the study tour group the opportunity to learn the importance of showing passion and dedication for learning. It was beneficial to hear some world leaders reinforce how essential it is for young professionals to have a will to make a difference and demonstrate that they are eager to engage and learn.

International engagements with multinational organizations demonstrated that job markets are incredibly diverse in STEM fields and therefore many jobs require holistic and multidisciplinary skills in addition to well-grounded technical knowledge (Australia’s Digital Pulse, 2016). Consequently, organizations recruit based on more than just technical capacity to complete a job, but also for future employee opportunities where they can grow and further develop with the organization and therefore successfully meet requirements

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of the specialized industry roles. This means that having a dedication to learn new skills, and going beyond what is mandatory is vital and important when producing better outcomes for all involved ("Lifelong learning: Continuous training and development is the key to business success", 2013). This was also identified by the world leaders who encouraged young employees to seek opportunities to improve themselves and gain training.

Moreover, this is closely aligned to the notion that one of the largest factors towards career-success is motivation (Ng & Feldman, 2014), and that having the opportunity to meet global market leaders, see how they engage in their roles, and be given the opportunity to learn about the possibilities available to someone just entering the global marketplace, was important to developing the inspiration to engage actively with the future job roles and therefore the organizations.

These days many skilled individuals work with colleagues from many different countries and backgrounds. Therefore it is vital to develop excellent cross cultural communication and interpersonal skills, so that future generations of employees are able to engage effectively (Zaugg & Davies, 2013). Communication is also seen as one of the most sought after skills in current graduates (GCA, 2015).

Over the course of the study tour, the group learned about the invaluable opportunities international engagements and internships can offer to students not only to support individual's personal developments but also to assist in improving cross border communication skills, nurture adaptability skills, and train graduates to meet commitments and duties in a reliable manner and provide student and future graduates with an opportunities to develop professionally utilizing the skills they have learnt in both class environments and within the practical and real life work setting (Sykes, 2009).

- **Learn how culture, customs and specific local regulations may impact system implementations in multinational organizations**

STEM careers are extensively becoming global. Many jobs are being integrated with industries other than purely science, technology, engineering and mathematics. Fields such as service, finance, administration, transport and sales are all requiring STEM knowledge and skills (Australia's Digital Pulse, 2016). Furthermore, large technology based organisations often outsource parts of their operations and therefore may often have supply chains that connect international distributors and suppliers. These connections encourage business exchanges across borders. Considering this, it is paramount for current students to learn about different countries and gain insights about the way work is performed across the globe. In particular, some technology operations may often be guided by local specifications and work parameters based on the region's specifications, laws and customs.

For example, the study tour students had the opportunity to visit large corporations in India that also operate in Australia and have realized that in different countries and regions, products may often differ, as well as the ways in which company approaches customers, and how the company approaches its marketing, delivery and even hiring. This often has impacts on company's information systems and operations which consequently need to be implemented in two countries in different ways, so they can successfully meet specific region's business outcomes and expectations.

This furthermore, strengthens the importance of understanding the drivers of a global businesses, the importance of society, lifestyles and life-goals of the individuals that are being involved in business exchanges and interactions. Therefore, it is important for future graduates to be able to understand the global ecosystem in which we live and learn about the wide scopes of international business interactions from outsourcing (Robinson, 2011) to collaborative engagements and complex multidisciplinary problem solving (Millar, 2016).

Furthermore, these multinational engagements require employees and business partners to have skills and knowledge that will enable them to easily communicate and understand each other while taking into account local customs and traditions. Moreover, there is also a need to learn how to best excel in a globally competitive market. Consequently, it is very important for the future graduates to learn and acquire leadership skills (GCA, 2016). While on the study tour, students learned from world class leaders about how crucial engagement and initiatives of young employees are and how important it is to engage in innovation and research early in their careers. They also strengthen the importance of internships. It is vital to note that study tour experience gave students the opportunity to consider wide range of the international engagements as after being exposed to work and life in a different country students are now more inclined to undertake future international engagements.

- **Learn about the different cultures and their business trends through both face to face and online exchanges**

Technology such as email, social networking, discussion boards, blogs and tools such as Skype and Zoom, help business and individuals cross geographical distances quickly. Tools such as these give opportunities to employees, business partners and students to collaborate, join projects and work together. However, what technology currently lacks is the ability to convey culture, habits, trends and environmental stimuli such as the context of air temperature, local customs, greetings particularly those exchanges when visitors come for the first time, welcomes and gift exchanges, participation in local customs as well as the immersion and acceptance of local rules, standards and regulations cannot be transferred electronically via social media tools and technologies.

These limitations can only be overcome if individuals are given the opportunity to travel and fully immerse themselves into the local setting. The study tour group had the opportunity to live in India, visit three well reputed universities, network with local students, engage in the activities that students in India would engage in as well as visit businesses, meet cutting edge business leaders and learn about the future opportunities. Furthermore, the study tour students learned first-hand about the business operations and how important it is for even the junior employees to follow their dreams, express their thoughts and engage in new innovative projects. The experience allowed study group to learn and apply these principles once they are to start working in their chosen career field. Now, students have learned how important it is to meet international teams face to face, to visit and attend meetings at their business partners' or collaborator's premises and gain the opportunity to learn and apply local rules and regulations, so that when the process of decision making is reached they can act swiftly. This knowledge can consequently give them the advantage over their competition.

Social media should not however be ignored. Its use and applicability should closely be integrated with the face to face interactions. Particularly for STEM professionals it may be quite easy to adjust and adopt to using various online tools and platforms to stay in touch and conduct ongoing business meetings and discussions. Therefore, these tools should be used to maintain networks, collaborate and share data, outcomes and plans. In addition, it is important to be aware that people are social beings and that therefore interactions can be more easily maintained if participants know and understand each other's environment and have met face to face. Study tour students have now established communications with companies they have visited. Based on this in the future it is expected that for the group that went on the study tour it will now be easier to approach these and other international companies. The study tour students have also had the opportunities to establish networks with student peers in India. In the future it is expected that contacts like these may initiate future collaborations and partnerships.

Based on the experiences of the study tour group experience students have now learned that whenever international contracts are being drawn it is important to meet other teams face to face, learn, understand and appreciate different cultures as well as continue to utilize social networking tools to nurture business relationships, stay in touch and continue to work on common initiatives.

3. FUTURE TRENDS AND OPPORTUNITIES

The study tour experience gave the participants an opportunity to see and experience firsthand integrations of the concepts learned as a part of their degree and majors in the real life business environments. Students had the opportunity to not only review the theoretical concepts learned in the classrooms but also see how those concepts are on a daily basis, being applied to real life operations in the business environments. Furthermore, this opportunity allowed students to reflect on what was learned in some of the core subjects of their degrees and in their majors. By observing the real life operations it was also possible for the students to link concepts learned during the degree together and see their full potentials in action which can directly be applied to specializations students are undertaking and their career goals. As per Kolb's learning cycles (Kolb 1984) it can be demonstrated that the knowledge gained over the course of the degree is being applied to real company scenarios while observing and engaging in actions with real business managers. The study tour also allowed students to grasp concepts in real time as they had the opportunity to interact with employees of the world class organizations. They observed the information systems companies implemented and learned about specific parameters that each industry and the region needed to take into the account, so that they can meet

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set business goals and deliver required outcomes. Furthermore, this experience allowed students to learn about the importance of how specific tools and technologies may need to be implemented, so that company's needs and requirements can be met and desired outcomes reliably and correctly delivered.

Therefore, it was seen that providing students with opportunities to see operations in action early on, network with peers domestically and internationally across various universities and by giving them the opportunity to visit some cutting edge organizations of a global caliber equips future graduates with skills essential for work in multinational corporations. As identified by study tour group it is very important for STEM students to be given the opportunity to speak to experts in their fields, to hear how industry sources employees globally and what opportunities are currently available, so that they can best position themselves within the globally competitive market.

It can be seen that education is changing and becoming more integrated with current jobs and industries. It is expected that components of the university education will remain formal and will be delivered via lectures, tutorials or workshops either face to face or online. Even today, in addition to formal teaching the Information Systems degree at Western Sydney University has been linked to real life projects that allow students to learn more about real life business operations. Allowing all students in the future to undertake international study tours as a part of their degrees will assist students in gaining deeper understanding. They will be able to compare local and international trends and learn about the cultures and habits companies in particular regions follow. Experiences like these will also assist future graduates and will help ensure future graduates are meeting industry expectations and are ready to engage in competitive jobs locally and internationally.

Furthermore, this experience allowed the study tour students to learn how best knowledge and skills gained in the classroom settings can be applied to real life companies, their strategies, operations and their systems deployment and management considerations both locally and internationally.

Through a study tour experience, students also gained the opportunity to learn first-hand what some large companies expect of future graduates such as how best to get ready for internships and how to navigate employment once they commence working. In addition, students also learned how crucial innovation, research and new opportunities are for large well established businesses and how closely they align to future job markets and opportunities.

Figure 1. From classrooms to global partnerships and collaborations

By undertaking the tour, students learned that future graduates currently need to be global citizens, and ready to utilize and apply knowledge learned within classroom settings to real life business operations (Figure 1). It is also essential for students to know and understand how skills gained within the classroom activities apply to jobs in the organizations both locally and internationally. Therefore, by opening doors to students and encouraging them to collaborate with companies early on in their degree both locally and internationally students will once they graduate, be able to adjust more quickly to new environments and better succeed in their chosen job.

Based on the retrospective reviews of the study tour it was identified that by encouraging students to engage in projects locally and internationally with the industry as well as network with peers domestically and overseas students will have opportunities to gain critical skills that recruiters require. For example, students will establish interactions with organizations learn about the company's cultural values and will also learn how important it is for them to be able to understand the local company traditions and habits in order to succeed. Furthermore, working and studying overseas may often challenge individuals' emotional intelligence. By having the opportunity to learn about the self-awareness, coping and resilience strategies while still students, once the students graduate, they will be equipped with skills required to deal with the unknown and unfamiliar circumstances. Additionally, successful problem solving and smart negotiating also requires careful planning. The planning often may be shaped by different circumstances, cultures and habits that will often also shape the natures of communications and negotiations. Based on the above, it can be noted that students who undertake study tours will have key skills recruiters are seeking. By attending study tours, students will also have the ability to learn how to operate in a different cultural settings and acquire more experience, so that they can swiftly respond to unique and unexpected circumstances (Davies, Fidler & Gorbis, 2013).

4. CONCLUSION

In conclusion it has been observed that even though technology is an integral part of our lives it is not possible to rely solely on it for international business partnerships, collaborations and the establishments of business operations and business ventures. This study identifies that in order for successful international business collaborations to be successfully conducted, it is paramount that future professionals while still students are exposed to international business settings and decision making opportunities. By allowing future STEM professionals while they are still studying to undertake international study tours it is expected that such experiences will allow them to learn more about the customs, habits and cultures of the other countries which would in turn help them easier understand the importance of local customs, laws and regulations as well as how at different stages of the information system implementations and use cultures and habits may be impacting local operations and decision making processes.

Furthermore, experiences like these are expected to give future graduates a cutting edge advantage as by partaking in study tours they would have the opportunities to learn about the local environments of the countries' visited as well as the business expectations of those countries and regions. The opportunity to participate in business visits, engage in meetings and observe business decision makers in action would allow future graduates the ability to adapt more easily and focus on tasks, solutions and innovations once they commence work.

Moreover, study tours like the one conducted, can open avenues to students in both countries, in Australia and those the Australian students visit, to meet, network and interact with their peers. Peers if they keep in touch, could in later years become each other's business partners and help each other engage in future international ventures. In addition, the organizations study tour students have the opportunities to visit can provided students with the key concepts, knowledge and feedback that is very important when learning how to tackle new markets. Students can also learn about how important their determination and will power are when working in both India and Australia and how top managers in both countries often provide strong support to those who express their desires to excel, innovate and do better.

In the future it is expected that traditional and even online teaching and content delivery methods will be closely linked to industry exposures and experiences and will also be very tightly aligned to international engagements and experiences particularly in STEM disciplines. By allowing students the opportunity to understand and experience global trends and demands and gain opportunities to experience and compare life and work in at least two quite distinctive countries, future graduates will be able to successfully learn about the crucial aspects of the international communications, negotiations and operations. It is also important to note that only once future graduates have had opportunities to engage in international exchanges and understand the global concepts on the ground, will they be able to establish successful international global exchanges and partnerships and meet demands of 21st century recruiters.

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A RETHINK FOR COMPUTING EDUCATION FOR SUSTAINABILITY

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ABSTRACT

The premise of Computing Education for Sustainability (CEfS) is examined. CEfS is described as a leverage discipline, where the handprint is much larger than the footprint. The potential of this leverage is described and the development of the field explored. Unfortunately CEfS is found not to be making sufficient impact in terms of a contribution at scale to system change actions resulting in restorative socio-ecological transformation. The paper considers why this might be, and what could be done about it. Two inspirations are described - a case study of a learner with an ambitious change aspiration, and a values-driven business. These lead to the presentation of an alternative model which while not exhaustive, is intended to provoke debate about the nature of computing education for sustainability.

KEYWORDS

Education, sustainability, computing

1. INTRODUCTION

The fields of education, computing and sustainability coalesce in Computing Education for Sustainability (CEfS). This can be seen as the combination of two disciplines with very high leverage, for change in a third arena - where the handprint, the potential to do good, is massively greater than the negative impact, the footprint. This CEfS should have the potential to be a significant agent for change. In this paper, however, I argue that we have largely failed in this mission, and a radical rethink is needed. Sustainability is considered here in terms of system change actions resulting in restorative socio-ecological transformation.

2. CEfS POTENTIAL

2.1 Education

Education can be considered a leverage discipline. Our service – our potential to do good – is vastly greater than our negative impact. Education for Sustainability (EfS) is fundamental to the global Sustainable Development Goals and most, if not all tertiary organisations have begun to address the operational aspects of sustainability. Many tertiary organisations can point to some element of their curriculum that focuses on sustainability. But few have addressed EfS in a holistic, multidisciplinary and systematic manner.

Otago Polytechnic is one tertiary organisation that has at least attempted this holistic EfS. In 2007 it adopted as a core strategic objective the statement that "every graduate may think and act as sustainable practitioner". With some tweaking of the wording, it remains so in 2016 - as illustrated in the opening paragraph of Otago Polytechnic's Annual Report:

> *"Guiding our students through a formative time in their lifelong learning journeys is a special privilege. At Otago Polytechnic, they engage in an experiential learning process and emerge as capable, work-ready, future-focused and sustainable practitioners".*

The Otago Polytechnic sustainability journey is explored in The Green Graduate (Mann 2011) and The Simple Pledge (Mann and Ellwood 2009). Rather than specifying a pre-determined set of behaviours to describe sustainability within a discipline, instead we aim to take students on a journey of themselves identifying what it means for them to think and act as a sustainable practitioner. In 2013, 93% of graduates agreed with the statement that “my learning experience developed my understanding of social, environmental and economic sustainability”. In the Graduate Employer Survey (2012 data), 94% of employers rated “Demonstrate an understanding of social, environmental and economic sustainability” as a criteria for employment as very high, high or moderate, and 87% agreed that Otago Polytechnic graduates demonstrated this attribute. In 2013, the international benchmark AUSSE survey asked respondents to rate the learning experience on a number of dimensions, including "the learning experience…contributes to living in a sustainable way". Otago Polytechnic respondents were considerably more agreeable than the benchmark (58% agree, national and international benchmark groups both 35% agree).

2.2 Computing

Computing also has the promise of being a leverage discipline. Despite a very large and troubling footprint, the potential handprint of computing is far greater.

Computing’s footprint is indeed troubling. Even if we just consider climate change (and we shouldn’t as sustainability is very much wider than that, but energy and carbon are useful proxies), computing’s infrastructure contributes about 2% of anthropogenic greenhouse gas emissions (Preist and Mann 2013, Raghaven and Mann, 2016) - about that of the aviation industry.

This problem is huge and we need to do everything we can to reduce this burden on the planet. But our potential handprint is bigger, much bigger. If we just consider climate change (again noting the qualification on this narrowing), Skip Laitner estimates that our society runs on about 14% energy efficiency “we are wasting most of what we produce” (Laitner *et al.* 2014). While not the only solution – we need to consume less too – a big chunk of the gain Laitner describes can only come from ICT enabled systems improvements, perhaps as much as 30-40%.

2.3 CEfS

So, education has a high potential leverage, and computing has a high potential leverage. The potential for combining them as Computing Education for Sustainability (CEfS) is very appealing. In terms of making a difference - contributing to a socio-ecological transformation, this could make a big impact.

In practice, Otago Polytechnic’s computing degree has seen a wide variety of sustainability related capstone projects performed for industry “client” partners.

- An app for managing wildlife interactions on beaches
- A device for mapping cycle-traffic “near miss” passing interactions
- A local food cooperative
- A home-based solar power management
- An electric vehicle control system
- A hybrid physical and digital social enterprise education game
- A support system for disadvantaged and vulnerable learners
- A game for teaching sustainability via a farming simulation.
- A game for teaching peace and conflict resolution
- A system for supporting distributed funding for charities
- A management system for reusing eWaste
- A food footprint calculator
- A source map for local food
- A citizen science based tool for rocky shore environments.

Sustainability is not a requirement for the capstone, but it is interesting to note that in their last major projects, and without a requirement, students are seeing this area as a useful vehicle for integrating skills learnt in the degree and that industry clients are seeing value in these projects.

In 2007, we began a series of papers on an agenda for computing education for sustainability. We first linked sustainability and computing, quoting United Nations Secretary-General Ban Ki-Moon who argued that that "information and communications technologies (ICT) are crucial in spurring development, dignity and peace". He argued that we should "turn the digital divide into digital opportunity" and that ICT should be promoted "in fighting poverty, illiteracy and disease, in protecting the environment and empowering women and girls". We stated that "as computing professionals we need to examine what role we see computing professionals playing in that future. As computing educators charged with creating those computing professionals we are doubly responsible, as we also have put in place the system to get us there" (Mann and Smith 2007a). In Mann and Smith (2007b) we took up this challenge and described the drivers for an emergent field of Computing Education for Sustainability. We explored options for including sustainability in computing qualifications. We looked for, but couldn't find whole degrees in Sustainable Computing, indeed whole courses were similarly elusive. Our preferred approach was one of "critical inquiry and integration throughout the curriculum in ways that are both incremental and transformative" (2007a).

The paper (Mann and Smith 2007b) concluded with a suggested agenda for developing CEfS. After further workshopping at a national conference, an agenda was agreed by the National Advisory Committee on Computing Qualifications (NACCQ). NACCQ (then its successor organisation CITRENZ) added sustainable practice to all computing qualifications. Most recently, in 2013-2015, all sub-degree computing qualifications were completely rewritten in government mandated review. All such New Zealand computing qualifications now include explicit requirements for sustainable practitioners in the graduate profile outcomes. On an international level, a series of workshops at ACM's ITiCSE conference (Mann *et al.* 2008, Mann *et al.* 2009, Goldweber *et al.* 2013) brought CEfS to the attention of international computing educators. The eventual outcome of this was the recognition of the sustainable practitioner in the ACM CS2013 Core Curriculum as a Core Tier 1: "Identify ways to be a sustainable practitioner".

3. WHY NOT A SUCCESS?

Unfortunately, if we return to sustainability in terms of system change actions resulting in restorative socio-ecological transformation, little progress has been made.

If we take the example of Human Computer Interaction (HCI), seminal papers such as Blevis' Sustainable Interaction Design (2007) prompted a flurry of research in sustainable HCI. However, as Brynjarsdottir *et al.* (2012) found, much of the resultant research is weak and focusses on a limited framing of sustainability and human behaviour, or, as Meyers and Nathan (2016) bleakly described, with an "impoverished" focus.

Computing does need to address its own footprint and it needs to educate people to do this. And it does need to maximise its handprint, and again we need to educate people to do this. But so far we have been very poor at the handprint, and even in the footprint have gotten largely stuck on energy efficiency, with limited effectiveness and quite possibly doing sustainability a disservice through misaligned values (Knowles *et al.* 2013, Knowles *et al.* 2014).

Beyond climate change, it is not hard to trace the footprint of impacts of computing on environmental degradation and social justice - as an example, to follow the pathways from our mobile devices to the inhumane conditions of the "artisan" cobalt miners of the Congo.

On the handprint side, computing for sustainability cannot be just about efficiency gains, and the problem is not just about carbon or energy. How can computing help reverse biodiversity loss? Or massive global inequities? Nor is it just about "the environment" – the systems in question are as much social as they are biophysical. As a society we have to learn to live in a complex world of interdependent systems with high uncertainties and multiple legitimate interests. These complex and evolving systems require a new way of thinking about risk, uncertainty, ambiguity and ignorance (Stagl 2007). These systems require that we can think simultaneously of the drivers and impacts of our actions across scales and barriers of space, time, culture, species and disciplinary boundaries. It means that we need to switch from a focus on outcomes to one of process. Ethics and sustainability can often be described as wicked problems - rarely as simple as choosing between an obvious good and an obvious bad. We need to be thinking about every decision, every action contributing to a system operating under ethical principles. Sustainability provides a framework for expanding ethical reasoning to a complex world.

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While we can identify small pockets of CEfS that approaches the goals of the previous paragraph, as a whole the situation can perhaps be best described by Meyer and Nathan's "impoverished sustainability".

Stephen Stirling (2004) argues that education for sustainability must be transformative for the learner, and to achieve that, education itself must be transformed. The remainder of this paper asks the question, if we were to transform computing education for sustainability, what might it look like? I do not provide any definitive answers to this, but offer two inspirations for this reframing. The last section discusses implications.

4. INSPIRATION 1: RIMU BODDY

Rimu Boddy is making New Zealand's Quota Management System easier to use, improving compliance, and adding value to the fishing industry (Rimu's name and story are used here with permission). He graduated with a Bachelor of Information Technology from Otago Polytechnic in 2012. Rimu was not an A+ student but he came with a very strong passion - to make a difference in the fishing industry.

Imagine the reckless swearing alcoholic rough fisherman. That's me. And still is.

Rimu was dissatisfied with the way the Quota Management System worked in practice. It was not realistic to expect fishermen to complete a complex paper form every time they put the net out. Unsurprisingly, compliance was low, as low as 15%.

I had an idea - and went to Otago Polytechnic to make it real.

I left fishing to go to Otago Polytechnic with a loose idea to use IT to do something better for fishing in terms of information flow - or something, I knew there were gaps.

Rimu had an idea, that technology could be harnessed to improve the information flow, but he realised he needed to gain the skills to develop his idea. His focus during the degree was almost entirely on his idea.

Throughout each class - I asked questions directly relating to the project. This got annoying, but the tutors always answered - even when we go a bit off topic.

Business analysis was basically what the preliminary project was for me.

This was when things started to take shape.

The going was tough, both financially and academically

I had a son, had very little money saved.

I worked at nights at the newspaper - and struggled to understand Java. The bits I'd missed in the 1st year were crippling. But over time and with lots of study - the details started to sink in

Rimu's capstone project was always going to be on his fisheries system - by now referred to as "fish bucket".

I spoke to lecturers early on regarding the possibility of creating something as a third year project. The reaction was completely supportive.

3rd year project, came with much excitement.

The same core concepts I learned in the 3rd year I still apply today. Loads of public speaking - in front of the class and more was another key element.

The other half of what was needed - making something that users can actually use was all the "other work" - what I still see as the bulk of any project; that process was laid bare in the 3rd year project, the absolute messiness of it all.

During the final year of his IT degree, Rimu entered in the student business entrepreneurship competition and emerged a category winner, and eventually winning the National Business Review student business competition.

By the end of the 3rd year - scraping through a few classes I had a business model and a software model. Some lasting friendships, and - a barely working set of prototypes. And all the connections I would need to move the project into a business.

The following years, Rimu continued to work on his project with a business incubator, supplementing his income with work for other organisations, and returning to fishing.

Toward the end of that year I was hired as a tester for HPSport - through connections at the Polytech.

I managed to upskill there while - working with Dunedin based Upstart to try to get the project into production with Talley's.

Underfunded and under skilled I couldn't pull it off despite Conrad Anderson's and my best efforts, we couldn't get traction.

During that time, Rimu was the client for a further BIT capstone project

Otago Polytech provided us with a student to do part of the project as a 3rd year project that went seriously well.

And the roller-coaster development continued:

The initial trials went well but I ran out of money and went back to Fishing for 4 months.

The electronic reporting solution CEDRIC was seen as too big and powerful to replace, and the integration with it was both legally and technically tricky. The timing wasn't yet right. The Ministry were beginning to scope out a similar project - based around compliance and surveillance.

I was introduced to 2 skippers and we gained dispensation for them to use the system for real. Initial trials were a success and I was invited to Auckland to meet with AFL.

We decided to team up - and bring the two projects into one business

The business is making a difference

Now we have trials with 3 fishing companies - we are in constant contact with the Ministry and are consulting with them on their compliance project.

We are helping to shape the way fishing is assisted by technology and bringing in added value throughout the whole process.

And new opportunities and challenges emerge

We have 5 employees - and couple part time. I spend my days developing mostly and other times Business direction and strategy. We are currently attempting to enter the US.

If I was to return to study it would be communications - to be honest I really need a refresher right now!

Rimu is now acting as client for the capstone projects for six Information Technology students.

Everything is difficult - at every level it gets harder. Coping strategies fail, and have to make new ones. But determination and having the support of others makes it all possible.

At every step the Polytech has been there for support connections and ideas long after the degree was all done and finished.

Rimu's learning pathway is unique, but his approach is not. Many students come to learning with a passion or a specific goal in mind, only to have that aspiration dulled by squeezing it into a fixed curriculum.

5. INSPIRATION 2: SUSTAINABILITY MATURITY

The child's bike manufacturing company, Wishbone Design Studio is owned and managed by Rich Latham and Jan McIvor (2016). The business is values-led, entirely based on a framework of sustainability and quality. Wishbone's dream was for a product that would last from ages one to five, and then be passed on to the next young rider. They wanted a principle of a 100% repairable product "that would never end up in the landfill" and they actively promote a second-hand market. A recent product innovation is the use of recycled carpet for the bike frame. The role of values infuses the business and the relationship with customers "because we declared our values early on – sustainability and quality – we were attracting customers of that same ilk, the pressure on us was not to drop standards, but to raise them".

On Willard's sustainability maturity model (2004), Wishbone is operating at the highest level "Sustainability-based thinking, perspectives, and behaviours are integrated into everyday operating procedures and the culture of the organization". Although anecdotal, I'm yet to find a computing organisation (research or commercial) above three on this scale: "Stage three is about incremental, continuous improvements in eco-efficiency".

It would be useful for CEfS to consider positioning itself on Willard's scale. What would computing education for sustainability look like if we did it from the same mindset as Wishbone does business? Can we imagine CEfS imaginering around strong values positions, making then breaking conventions?

6. IMPLICATION

What might these inspirations mean for CEfS? I believe that the original framing of CEfS didn't go nearly far enough.

If we look at the description of the agenda described in Mann and Smith (2007b) the preamble states: *"We hope that it is empowering and engaging. It is deliberately both top down and bottom up. It is deliberately both incremental and transformative. It is deliberately aimed at the champions and the "ordinary lecturer". It deliberately challenges (without pushing anything "down my throat") and provides resources to encourage".*

In retrospect, perhaps we should have challenged more. Just putting a bit of recycling and procurement into the hardware course is not enough. While we may have gotten to a point where sustainability is in many computing qualifications, perhaps this "sustainability as usual" is doing a disservice.

Maybe rather than carefully aligning sustainability with the discipline, we need to be pointing out how much change is required. Huish's (2013) teaching of Development Activism, or "Dissent 101" might be a useful model here.

6.1 Alternative

CEfS has largely been carried out within existing education pedagogy. Otago Polytechnic has adopted a heutagogical-based teaching and learning strategy that has radical impact for education. The strategy can be considered with a device recognisable to those familiar with software engineering's Agile Manifesto:

At Otago Polytechnic we have to come to value:
Processes of learning over focus on content
Lecturers as co-learners over lecturers as experts
Learner-managed learning over lecturer delivered learning
Learner-negotiated projects over lecturer defined projects
Assessment as a learning process over assessment as a summative process
Flexible learning opportunities over timetabled teaching times
That is, while we value the items on the right, we value the items on the left more.

Exemplifying this approach is the work-based learning approach of CapableNZ - the Otago Polytechnic school of professional practice. This school works with learners to recognise and extend learning in a professional work-based context at both undergraduate and post-graduate levels. At undergraduate levels CapableNZ works with learners to align their professional framework of practice - their professional identity - with graduate profiles, including the computing degree. These learners would be expected to learn new areas, mostly to wrap their practice in theoretical context, but there are no formal classes. Instead the focus is on reflection.

On the basis that sustainability problems are not amenable to single-point interventions (because they are both wicked and numerous), we need a step-change in how we approach computing for sustainability. Rather than trying for separate interventions for every aspect, or for passive awareness, focus needs to be placed upon engaging people to affect worldviews. This deeper engagement might be through community conversations, through reflection and action research. Some computing researchers are beginning to recognise this as the next step (Silberman *et al.* 2014). Batya Friedman's (2016) multi-lifespan information systems have really looked at how we might start to address intergenerational equity. Some are working on community engagement, not as a means for behaviour change, but for the sake of an empowered community: Steve Benford's trajectories and uncomfortable interactions (Benford 2013), University of Lancaster's work on Tiree (Ferrario *et al.* 2014), Rob Comber's empowering communities (Comber 2016) and David Green's participatory documentary making (Green 2016). These research directions are supporting communities to create sustainable futures beyond a behaviour-change-intervention-via-new-product paradigm.

In order to contribute to this engagement focussed computing for sustainability, education also has to change. Bennett (2008) describes "anupholesteraphobia: the fear of not being able to cover the material" where the solution is not to try and cram more material into an already crowded curriculum, but rather to see sustainability as the context, a basis for deeper learning, or even a reason for learning.

Instead of formally teaching computing (or any other discipline for that matter), Education for Sustainability could focus on professional development and work practice - where that work is explicitly sustainability. Could we market a "Bachelor of Making a Difference" where learners are supported to undertake major projects - such as Rimu's fisheries logistics development? Learning of technical content would be on-demand as needed for the project. In Rimu's case, that on-demand learning would have included a lot of computer science, but also business management, policy development and marketing. It wouldn't be a Computer Science degree, but it would have been better in supporting his aspiration and career – and making a real difference for a sustainable future.

7. CONCLUSION

This work has been prompted by the author's increasing unease with the ability of CEfS to deliver a professional workforce committed and capable of the leverage that computing has promised in sustainability. This paper has argued that we need to step outside our comfort zone and engage in an activist approach to computing education. Previous attempts to demonstrate how sustainability fits into a computing education paradigm has not resulted in the required contribution at scale to system change actions resulting in restorative socio-ecological transformation. An alternative model is presented, which while not exhaustive, is intended to provoke debate about the nature of computing education for sustainability.

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TECHNICAL EDUCATION AS A TOOL FOR ENSURING SUSTAINABLE DEVELOPMENT: A CASE OF INDIA

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ABSTRACT

This paper notes that education needs to essentially lead to sustainable development serving two-fold purpose – eradicating the problems of unemployment and poverty; and ensuring equitable distribution of wealth while ensuring the right understanding leading to a peaceful, prosperous and developed world. In its current state, technical education doesn't seem to serve the above two objectives. The paper presents a holistic view of technical education in India. In order to ensure sustainable development for India in the contemporary global scenario, the paper finds technical education to be one of the core competencies that need to be developed. The paper observes that there seems to be no linkage between the 'education' being provided in the country and these problems getting solved. In order to provide a real educational solution for all-encompassing development of India, the paper suggests that 'what to do' is the real question for technical education than just 'how to do'. The paper suggests a model for the State (province) of Punjab in India to elaborate on the model of technical education for sustainable development.

KEYWORDS

Sustainable development, unemployment, poverty, technical education, what to do, how to do

1. INTRODUCTORY REMARKS

Einstein maintains that the aim of education must be the training of independently acting and thinking individuals who see in the service to the community their highest life problem (Seelig 1954). Drawing inferences from the statement of Einstein, one can clearly state that the ultimate purpose of education is in ensuring service to the society in achieving the goal of the masses. The goal of every human in this world seems to be happiness (European Economic and Social & Committee 2008) and its continuity (Nagraj 2011). The objective of education is to facilitate the attainment of human goals by ensuring the right understanding among humans (Nagraj 2008), thereby ensuring the happiness for every individual at the levels of self, family, society and nature (Gaur et al. 2009). Such education will lead to sustainable development serving two-fold purpose – one, it will help eradicate the problems of unemployment and poverty; and two, it will ensure equitable distribution of wealth while also ensuring the right understanding leading to a peaceful, prosperous and developed world.

UNESCO (2016) defines sustainable development as an organizing principle for global development that supports the well-being of both people and the planet. The term encompasses environmental, economic and social concerns, attempting to investigate environmental protection and ecological integrity, economic viability, and social and human development. Nagraj (2009) goes a step further and maintains that only the development at the levels of self, family, society and nature can be sustainable for mankind.

Focusing on the technical education scenario in India, this paper brings out that in its current state, technical education doesn't seem to serve the above two objectives. The paper goes on to suggest the route for development of technical education system for ensuring sustainable development in India. The paper suggests a model for the State (province) of Punjab in India to elaborate on the model of technical education for sustainable development.

2. EDUCATION AND SUSTAINABILITY

Sustainable development is the one that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development requires meeting the basic needs of all and extending to all the opportunity to fulfill their aspirations for a better life (Brundtland 1987). Brundtland (1987) further argues that sustainable global development requires humans to adopt the lifestyles that are in synchronization with the planet's ecological means - in their use of energy. United Nations (1992) suggests 21 principles of sustainable development that largely deal with healthy and productive life in harmony with the nature; right to equitable development; eradication of poverty; environmental protection; quality of life; and women empowerment etc.

The concept of education cannot be confined to what happens in the classrooms. It extends to the daily and professional lives as well (UNESCO 2012). Therefore, education has to play a role in improving the lives of people in such a way that they live in harmony with other humans as also with the rest of the nature (Nagraj 2008).

There is immense literature that studies the role of education in development. However, a limited number of studies discuss the role of education in sustainable development (Basant & Chandra, 2007; Brundtland, 1987; Dyankov, 1996; European Economic and Social & Committee, 2008; Harmon, 2011; Kaul, 2006; Kemal, 2005; Krueger & Malečková, 2003; National Knowledge Commision, 2009; OECD, 2006a, 2006b; Ramani, 2014; Roy, 2012; Seelig, 1954; Tilbury, 2011; UNESCO, 2012; United Nations, 1992; Universities UK, 2002; Vrat, 2009).

Nagraj (2008, 2011) establishes that the real test of education is whether it gets the humans to understand the importance of relations (with other humans and the rest of nature) and facilities. In its current form, most of the education systems accelerate the blind race to accumulate more and more facilities and nearly ignore the relationship aspect. This is precisely the reason why current education system does not provide sustainable solutions to the problems of mankind (Nagraj 2009; Nagraj 2008; Gaur et al. 2009). An alternate education system needs to be developed – such that it focuses on developing the holistic understanding among humans. Such alternate shall provide solutions that cater to the problems of the locale and builds on the locational advantages prevalent in the area.

3. PRESENT STATE OF INDIAN HIGHER EDUCATION

Education is one tool that has to play significant role in building a strong workforce in the country, which gels well with the national objectives. Providing access to knowledge is the most fundamental way of increasing the opportunities of individuals and groups. Therefore, it is essential to revitalize and expand the reach of knowledge in society (National Knowledge Commision 2009).

The goal of technical education is to play a vital role in human resource development of the country by creating skilled manpower, enhancing industrial productivity and improving the quality of life. Technical education covers courses and programmes in engineering, technology, management, architecture, town planning, pharmacy and applied arts & crafts, hotel management and catering technology.

Basant & Chandra (2007) reveal that the Indian experience in developing and regulating technical education has had an immense impact on the development of public and private enterprises in the country. The paper also unearths that the key advantage of this regime has been the development of very diverse capabilities in manpower, thereby helping India diversify its industrial base. On the other hand, Vrat (2009) observes that the current scenario of technical education is a cause for concern, particularly on quality and employability front. It is necessary for the improvement of technical education in India that all stock holders should contribute towards the goal of making India a leader of knowledge of shared perceptions and concerns.

The higher education system in India has grown in a remarkable way, particularly in the post-independence period, to become one of the largest systems of its kind in the world. However, the system has many issues of concern at present, like financing and management including access, equity and relevance, reorientation of programs by laying emphasis on health consciousness, values and ethics and quality of higher education together with the assessment of institutions and their accreditation (UGC Golden Jubilee Seminars- 2003). India has to rise to the occasion urgently and reorient its higher education system to be vibrant, competitive, meaningful and purposeful; besides, there is absolutely no substitute to quality of higher education, although the country has been faced for a long time with the serious problem of meeting the quantity needs of our society. It is, therefore, essential that a careful balancing of the two is given priority to meet the twin requirements of the society in the foreseeable future (UGC Golden Jubilee Seminars- 2003).

There has been a rise in the number of educational (particularly technical) institutions operating in the country. The number of universities has increased (since independence) 33 times (666 universities as on 31st March 2014 as compared to 20 in 1950), the number of colleges – 79 times (39,671 colleges as on 31st March 2014 as compared to 500 in 1950), and the student enrolments have increased 113 times (237.65 lakh students as on 31st March 2014 as against 2.1 lakh students in 1950) since independence (UGC 2014).

Despite the increase in numbers of universities, colleges, and student enrolments, the higher education sector of the country has not been able to yield the desired results (UNESCO 2016). Education is essentially linked with human development. Any development in the educational facilities in the country needs to get reflected in the human development in the country. India, however, still lags far behind the other developing and developed countries in terms of Human Development Index. For 2013, the Human Development Index for India (ranked 135) stands at 0.586, while the same in Brazil, Russia, China, South Africa, Indonesia, USA, UK, and Japan is recorded at 0.744, 0.778, 0.719, 0.658, 0.684, 0.914, 0.892 and 0.890 respectively (United Nations Development Programme 2014).

One of the major reason for slow progress in the field of Human Development Index in India remains the employability concern. Table 1 summarizes the employability percentage of India engineering graduates in different roles (Aspiring Minds 2016).

Table 1. Employability Percentage of Engineering Graduates in Different Roles

Role	Employability
IT Roles	
Software Engineer – IT Product	3.67%
Software Engineer – IT Services	17.91%
Startup Ready – IT Services	3.84%
Associate – ITeS Operations (Hardware and Networking)	37.06%
Engineering Roles	
Design Engineer – Non IT	6.56%
Sales Engineer – Non IT	19.08%
Non-tech Roles	
Business Analyst – KPO	10.86%
Associate – ITeS/BPO	40.57%
Technical Content Developer	11.66%
Creative Content Developer	16.72%

(Source: Aspiring Minds)

The major reasons for unemployability in India may be attributed to the following factors in addition to other factors being reported by various studies/ reports.

3.1 Quality of training of Technical Graduates passing out of Indian Institutes is not of Global Standards

Students of Indian technical Institutes are trained on the software and operating systems of Microsoft, Oracle, Sun, Macintosh, etc. The teachers of Indian institutes are not trained well as these multinational companies don't have direct industry-institute interactions with the Indian educational institutions. On the other hand, teachers of the first world have direct access to these corporate for training and R & D purposes. Thus, they are far more skilled to train their respective students.

3.2 Expansion of Technical Education is not in the area where India can build an Advantage

India has a competitive advantage of having a vast geographical area having different climatic conditions ranging from sub-zero to high temperature (say 50 degree Celsius) having regions of moderate to very heavy rainfall with soil of different textures and different topographies. All these conditions provide a perfect ground to grow and develop the eatables ranging from spices, tea, fruits, and all sort of other foodgrains including dairy products for whole of the living creatures of the world. The technical education of the country needs to be expanded in such a way that it helps us in developing this crucial sector. The Computer, IT, Electronics, Biotechnology, Mechanical, Chemical, Civil Engineering coupled with different spheres of Management should be planned in such a way that the application of all these subjects is directed at developing the competitive advantage of the country. For example, Chemical and Bio-technology could be used to develop latest seeds and insecticides and pesticides. Presently, multinational companies like Bayer, Dupont etc are selling this product in the market. Similarly, mechanical and civil engineering techniques may be used for better irrigation while Management and IT could be used for information and marketing in the farming sector, which could help in the export of these commodities.

3.3 Placements of the Graduates are Dependent upon the Multinational Companies of the First World

In most of the educational streams, the graduates passing out of Indian education system are dependent on the multinational companies for their employment. Educational system of the country, not being able to produce graduates who can use their education to encash upon the geographic dividend available with India, leaves no other option but to look towards the MNCs. Any alternate educational model needs to focus on producing graduates who can do what they are good at, rather than what others (MNCs) are good at.

While on one hand, the increase in number of enrolled and passing-out students in the country has failed to increase the level of employment (Basant & Chandra 2007; Vrat 2009); on the other, the social problems of the country have touched new heights (National Crime Records Bureau 2015). The increase in number of crimes and suicides has been visible despite the increased number of students getting through the education system of the country.

The spread of education without being able to get the employment level rose in the country, on one hand; and without making any significant contribution to resolving the problems of the masses, on the other; merely seems to be the spread of schooling and not that of education.

4. VISION FOR INDIAN TECHNICAL EDUCATION IN CONTEMPORARY GLOBAL SCENARIO

Indian technical education must aim at overall development of the country by involving the development of all sections of the society including the services sector, industry sector, and agriculture sector. This would only be possible if the goals of technical education in the country are set-up in synchronization with the demographic characteristics of the country. The problem with countries like USA that are gripped with recessionary patterns currently, has been that only the technical know-how has been present in those countries while the other factors such as production, engineering, marketing, management have all been outsourced to other countries like India, China, Russia and Brazil. The Indian demography is strong and versatile enough to manage all these functions in-house leading to a solid competitive advantage. Therefore, there is a strong case for developing the technical education in India in line with the competitive advantage for the country in the global economy.

Mere imparting the skills (that are being imparted globally) does not fulfill this requirement. Technology being taught by present technical education system of the country only tells us ‘how to do the things’ without actually knowing ‘what to do’, which is far more relevant a question (Gaur et al. 2009). The vision for future of Indian technical education ought to start with knowing and deciding ‘what to do with technical education’. This question needs to be addressed keeping in mind the needs and competencies of the Indian citizens. Since agriculture is the core strength of India, the Indian model of technical education shall target at exploring this core strength. All the streams of technical education shall be developed in a way that helps strengthen the agricultural economy of the country. This is the ‘what to do’ part on the basis of which ‘how to do’ can be worked out.

There are examples present in the Indian education system itself where the technical programs customized as per the competitive advantage and needs of the country, emerged amazingly successful and served the purpose at all the four levels mentioned before. The post-graduate programs in agri-business management being offered by Institute of Rural Management, Anand (Gujarat) and Indian Institute of Management, Ahmedabad, are two of the significant examples that can be cited wherein the customization of higher education programs according to the competitive advantage of the country have produced great results at all the four levels. *One,* the equipped manpower produced by these programs has been grabbed by the industry with both hands leading to the happy and prosperous ‘self’ of these technocrats. *Two,* the placements of these graduates have been in their own State/ Country, thereby minimizing the need to migrate overseas unlike the Computers/Electronics/IT engineers, leading to happy and prosperous ‘families’. *Three,* they are also serving the Indian ‘society’ by guiding the farmers. *Four,* they are involved in improving the production and quality of food-grains without exploiting the natural resources or the human beings, and this production is in harmony with the ‘nature’.

5. POTENTIAL OF TECHNICAL EDUCATION FOR ENSURING ALL-ENCOMPASSING DEVELOPMENT – A CASE OF PUNJAB

Before moving on to discuss the potential of technical education for ensuring all-encompassing development with the example of Punjab, the paper presents table 2 and 3.

Table 2. Minimum support prices of foodgrains in India

Marketing Season	MSP of Wheat MSP+Bonus	MSP of Paddy			MSP of Coarse grains
		Common + Bonus	Grade A + Bonus	Jowar/Bajra/ Maize/Ragi	Barley
2007-08	850	745	675	600	565
2008-09	1000	900	930	840	650
2009-10	1080	1000	1030	840	680
2010-11	1100	1000	1030	880	750
2011-12	1170	1080	1110	980	780
2012-13	1285	1250	1280	1500	980
2013-14	1350	1310	1345	1500	980
2014-15	1400	1360	1400	1530	1100
2015-16	1450	1410	1450	1570	1150
2016-17	1525	1470	1510	1625	1225

(All MSPs are Rs/quintal) *(Source: Department of Food and Public Distribution, Govt of India)*

Table 3. Subsidies to agriculture in India during Tenth and Eleventh plan

Plan Period	Year	Budgetary subsidies (CSO)	Food Subsidy	Total Fertiliser subsidy	Subsidy on Indigenous Urea	All Other Agriculture Subsidies	Total agriculture related subsidies
Tenth Plan	2002-03	43597	24176	11215	7790	16196	102974
Tenth Plan	2003-04	43765	25181	11847	8521	15258	104572
Tenth Plan	2004-05	47655	25798	15879	10243	16221	115796
Tenth Plan	2005-06	51065	23077	18460	10653	20181	123436
Tenth Plan	2006-07	59510	24014	26222	12650	21924	144320
Eleventh Plan	2007-08	85698	31328	32490	12950	34830	197296
Eleventh Plan	2008-09	156823	43751	76603	17969	54438	349584
Eleventh Plan	2009-10	139248	58443	61264	17580	37121	313656
Eleventh Plan	2010-11	150170	63844	62301	15081	39106	330502

(All subsidies are Rs in Crores) *(Source: Govt of India)*

The potential for technical education can be best explored if it is utilized in serving the purpose of society at all the four levels mentioned before. A case of Punjab is presented hereunder just as an example in that regard. Despite the increase in Minimum Support Price of two major crops – Rice and Wheat – (refer to Table 2) and increases in the subsidies available to the farmers (refer to Table 3), the news about farmers committing suicides have been flowing in. To add to this, there have been a larger number of students graduating out of the technical institutions of Punjab. Most of these graduates seem to be lacking the awareness, engineering vision and capabilities to visualize the problem of the State leave aside solving them. Further, the lack of awareness among *Punjabis* regarding (i) the effects of insecticides & pesticides; and (ii) right understanding regarding the prosperity, is leading the farming class to resort to the excessive usage of fertilizers and exploitation of under-water resources with an objective of increasing their produce. This, in effect, has exposed Punjab (particularly the *Malwa* region) to the dreadful disease of cancer threatening the whole of the Society. Furthermore, the industry in the State seems to be lacking the direction for future development. For example, the technical education has failed to localize and provide winnable solutions for the Steel industry (at Mandi Gobindgarh and Batala), Leather and Sports-goods industry (at Jalandhar), Textile and Auto-components industry (at Ludhiana). Further there has been a failure to set-up food-processing industry in the State, as also a failure to set-up chains of high-tech warehouses to store perishable food products.

These problems identified above may also turn out to be the competitive advantage for the State if a need and competency based model of education can be developed for the state. For technical education, issues like these need to provide basis for recognizing and deciding 'what to do' for inclusive development of the State. The geographical and demographic dimensions of Punjab are ideal for agriculture. Therefore, there is great potential for the State to prepare a development model for itself around the agriculture sector. Education can play a lead role in this respect if the educational model is prepared for supporting the sector. All the streams of education can be developed to prepare the graduates who can work towards this end rather than just producing the 'routine employees' for multi-national corporations. Figure 1 presents an example of how three streams of technical education (management, electronics and computers engineering, and biotechnology) can be placed in this model. The roles of other streams can also be defined in similar way while designing the model of technical education for the State.

Management Graduates

(i) Study demand-supply gap in agricultural products; (ii) build laison with the farmers who can produce to plug this gap; (iii) start entreprenurial projects that can act as a bridge between the farmers and the potential consumers; (iv) involve corporate world to facilitate this marketplace; (v) facilitate the agricultural extension; and (vi) identify and play other roles required towards the sustainable agriculture.

Electronics and Computer Engineers

(i) Build competitive edge via agri-electronics; (ii) ensure speedy and economic access to information for the farmers; (iii) build strong electronic and mobile network for facilitating the marketplace; and (iv) identify and play other roles required towards the sustainable agriculture.

Biotechnology Engineers

(i) Develop better seeds for the crops having potential market; (ii) explore natural methods of agricultural production; and (iii) identify and play other roles required towards the sustainable agriculture.

Figure 1. Placement of three streams of technical education in development of agriculture sector

Applying such a model will lead to digitized green revolution, which promises a catalytic role in national economic development in terms of diversification, enhancing productivity, adding value, capturing markets, mixing farm & off-farm income, entering and creating marketing chains, improving food quality & safety, ensuring healthy society and balancing ecological interest.

6. CONCLUSION

The paper presents a holistic view of technical education in India. In order to ensure sustainable development for India in the contemporary global scenario, the paper finds technical education to be one of the core competencies that need to be developed. It is observed that despite the increase in number of educational institutions as also the number of enrolments in higher education programs in the country, the problems of unemployment, poverty and social evils are looming large on the country. There seems to be no linkage between the 'education' being provided in the country and these problems getting solved, which is contrary to the belief expressed by Albert Einstein. In order to provide a real educational solution for all-encompassing development of India, the paper suggests that 'what to do' is the real question for technical education than just 'how to do'. The paper also presents a case-study for ensuring futuristic growth of the technical education in Punjab that revolves around the core strength of the state (i.e. agriculture) and helps achieve happiness through right understanding and prosperity at all the four levels, i.e., Self, Family, Society and Nature.

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EVALUATING ECO-INNOVATION OF OECD COUNTRIES WITH DATA ENVELOPMENT ANALYSIS

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ABSTRACT

Government regulations require businesses to improve their processes and products/services in a green and sustainable manner. For being environmentally friendly, businesses should invest more on eco-innovation practices. Firms eco-innovate to promote eco-efficiency and sustainability. This paper evaluates the eco-innovation performance of Organisation for Economic Co-operation and Development (OECD) countries with data envelopment analysis (DEA). Data were gathered from the world bank database and global innovation index report. Findings show that for most OECD countries, energy use and ecological sustainability are more important than other inputs and outputs for enhancing eco-innovation.

KEYWORDS

Eco-innovation, Data Envelopment Analysis, Sustainability, Eco-efficiency

1. INTRODUCTION

Discussions about climate change and the dangerous environmental effects of humankind require a broader research focus on sustainable, eco-friendly and/or green behaviour. (Haws et al., 2014; Teichmann, 2016). Organizations must provide green education and training for the growth and application of cleaner and more efficient technologies regarding natural resources utilization (Martin and Rigola, 2001).

Eco-innovations are solutions purposefully planned to minimize the environmental effect of manufacturing, consumption and discarding activities, even if their primary incentive is to capture opportunities and take advantage from environmental issues (Neto et al., 2014). Eco-innovation can be seen as an essential real economic facilitator (Montalvo et al., 2011). Interrelationships among many actors such as consumers, communities, and suppliers, in addition to firms are another significant characteristic of eco-innovation practices (Mele and Russo-Spena, 2015). It is expected that eco-innovation practices can deliver “lower consumption of natural resources, new sustainable energy generation methods and new eco operating practices and products” (DECC, 2010). Many activities are essential in making eco-innovations successful, such as training staff on environmental concerns, including environmental communications in product packaging; decreasing the volume of packaging used in the products vended; funding environmental activities in the society; and utilizing reprocessed material in packaging products sold (Martin et al., 2013).

The survey by Eurobarometer (2011) revealed that 76 percent of organizations within the European Union (EU) have devoted in eco-innovation solutions since 2006. 41 percent of that companies spent more than 10 percent of their innovation budget on eco-innovation, whilst 16 percent invested over 30 percent of their innovation budgets on it. Some of eco-innovation activities such as less material usage, less energy usage, minimizing carbon dioxide (CO2) footprint of companies, utilizing less pollutant material, decreasing soil, water and air pollution and recycling more waste can add value during the manufacturing stage. On the other hand, activities like decreased energy use, decreased soil, water and air pollution and enhanced recyclability of the product after use may add value to the post sale usage of the product (Doran and Ryan, 2014). It is evident that using resources efficiently could significantly diminish firms’ operation costs. Therefore, firms can invest more on innovation activities especially eco-innovations. Such activities play a vital role in creating new job opportunities and delivering strategies for eco-efficient and sustainable growth.

To this end, firms and countries must meet eco-innovation principles with material efficiency, minimizing greenhouse gas emissions, enhancing recycling and minimizing pollutions (water, air and soil).

The Background Statement for the OECD Global Forum on Environment on Eco-innovation in November 2009 declares: "Most OECD countries consider eco-innovation as an important part of the response to contemporary challenges, including climate change and energy security. In addition, many countries consider that eco-innovation could be a source of competitive advantages in the fast-growing environmental goods and services sector" (OECD, 2009a).

DEA is a nonparametric linear programming based technique for measuring efficiency and evaluating the productivity of homogenous decision making units (DMUs). DEA is extensively used in various fields such as eco-efficiency analysis (Egilmez et al., 2016; Masuda, 2016; Mahdiloo et al. 2015; Lorenzo-Toja et al., 2015; Avadi et al., 2014) and technology innovation (Sueyoshi and Wang, 2014). Therefore, this paper aims to determine eco-innovation of OECD countries via data envelopment analysis (DEA). For the first time, this paper measures eco-innovation using DEA. The remainder of this paper is organized as follow: Section 2 briefly reviews the literature of eco-innovation. Section 3 presents research methodology used. In Section 4, an illustrative case study is analysed. Finally, Section 5 concludes the paper.

2. LITERATURE REVIEW

Eco-innovations are those activities which aim sustainability of environment (Rennings et al., 2008) and all companies and non-for-profit organizations can develop them by promoting their existing practices. Therefore, it also can be called environmental innovation, green innovation or sustainable innovation (Halila and Rundquist, 2011).

Oslo-Manual of the OECD (2005) described four traditional modes of innovation as follow:

- Process innovations are the result of producing the same amount of goods and services by consuming fewer amount of inputs.
- Product innovations need to improve present products and services or even initiate new goods and services.
- Organisational innovation requires establishing new management philosophies in the organization such as 5S and total quality management.
- Market innovation is important for the promotion and pricing of products and services, and other market-oriented strategies.

On the other hand, the main theme in eco-innovations is deliberate intention to minimize the environmental impact of products and processes (Leitner et al., 2010) to promote living conditions of present and future generations (Halila and Rundquist, 2011). Removing or minimizing CO2 emission is very important factor in eco-innovation.

Some companies simply innovate by replacing dangerous material, consuming less energy, managing waste and minimizing pollutants, while other firms tend to design technologies to control pollution and waste management (Doran and Ryan, 2012). Incorporating sustainability as an obvious objective in the design process and turning environmental innovation strategy to a pertinent element is essential in adopting eco- innovation to warrant significant business performance and better internal efficiency (Tseng et al., 2013; Bossle et al., 2016). On the other hand, attitudes of senior management toward risk and technology advancement overtime are important factors in initiating eco-innovation. (Bossle et al., 2016).

From the business point of view, eco-innovation efforts lead to better organizational performance (Santos et al. 2014). Investment in eco-innovation may have other benefits as improvement in the competitiveness of the firms, higher profit margins, decreased pollutions and waste (Porter and van der Linde, 1995), reduced costs, reduced risks, increased sales and profit margins, improved reputation and brand value, being more attractive as an employer, and building up innovation capabilities.

It must be noted that well-designed governmental regulations and supportive organizational procedures can lead to eco-innovations (Halila and Rundquist, 2011) through risk and uncertainty management, increasing cooperation among innovative agents and limiting activities of free riders (Caiazza et al., 2014).

Doran and Ryan (2012) categorized eco-innovation drivers into for groups of (i) Regulation and government support, (ii) Perception, (iii) External linkages and (iv) Knowledge generation (Doran and Geraldine Ryan, 2012). Wah and Fernando (2015) claim that drivers of eco-innovation are five groups of regulation, technology, cross-functional coordination, supplier involvement and market focus drivers. Diaz Lopez and Montalvo (2015) classified top factors of eco-innovation in the chemical industry into technological, institutional, organizational, markets, economics and society factors.

Klewitz et al. (2012) found that the proactive perspective by a public intermediary is one important push factor to activate eco-innovations in SMEs with low absorptive capacity. Other reasons for eco-innovation can be meeting demand of consumers (Horbach, 2008), pressures of interest groups (Wagner, 2007), variations in regulation (Porter and van der Linde, 1995), economic concerns such as reducing costs (Barsoumian et al., 2011) and developing socially responsible strategy (Saxena and Khandelwal, 2012).

Yang and Holgaard (2012) point out particular aspects of eco-innovation as follow:

(i) Intents towards environmental benefits: While most of authors emphasize on environmental benefits of eco-innovation, others clearly focus on economic value generated by eco-innovation. Also, both intentional and unintentional innovations which lead to environmental advantages are considered as eco-innovations

(ii) Double externality problem: Environmental benefits are positive spillovers for the society, but it might be a problem for innovative organizations, since it needs extra investment in environmentally friendly solutions. Here, the issue is that such investment must be paid only by the innovative organizations themselves while the whole of society utilize gained environmental benefits.

(iii) Regulatory push/pull: Policies and regulations should support firms that produce eco-product/services more than firms that do not produce eco-products/services to help them to gain a market niche. But pioneer companies are often proactive enough to affect the formulation of sector standards and regulations.

Sanjuan et al. (2011) used data envelopment analysis (DEA) for Spanish Mahón-Menorca cheese production to measure the eco-efficiency of production Techniques. Jansson (2011) examined factors driving and hindering adoption of eco-innovation. Findings show that adopters and non-adopters differ on norms, attitudes, novelty seeking and on how innovation attributes are perceived. Tsai and Liao (2016) developed a logit moderating regression model to investigate the role of a proactive environmental strategy on eco-innovation. They found that market demand, innovation intensity and government subsidy influence the effects of sustainability strategy on eco-innovation. Wan et al. (2015) evaluated the eco-efficiency of industrial enterprises by developing a regression model. The inputs of (1) total industrial wastewater discharge, (2) total industrial exhaust emissions (billion cubic meters), (3) total emissions of industrial solid waste, and (4) energy consumption per unit of industrial added value are used for determining industrial added value as output. Ji (2012) investigates the impact of product innovation and energy level jumps on clean trajectories developed on the basis of practices in China. Ding (2014) found that joint innovation capability plays a significant intermediary role in the transformation of supply chain collaboration to eco-innovation performance. Also, organizations must keenly participate in internal R&D because it positively influence the efficacy of supply chain collaboration in firm's proactive environmental practices.

3. RESEARCH METHODOLOGY (CCR-O MODEL)

This paper aims to evaluate the eco-innovation of OECD countries based on common inputs and outputs. Because the inputs/outputs are assumed to be independent and the number of countries is 34, DEA can be the best choice for their evaluation. The CCR (Charnes, Cooper and Rhodes) model introduced by Charnes et al. (1978) evaluates relative efficiency of DMUs. Conventional DEA models as CCR and BCC (Banker, Charnes and Cooper) based on linear programming for calculating efficiency score of DMUs. CCR models (both input and output oriented) assume that constant return to scale prevails. The output oriented CCR model estimates maximum radial output expansion of the evaluated DMU such that the projection of it is within the production possibility set. Linear programming corresponding output oriented multiplier form of CCR model is as Model (1). For any DMU_j ($j=1…n$) of this model, it uses m inputs x_{ij} ($i=1…m$) to produce s outputs y_{rj} ($r=1…s$) (Charnes et al., 1978).

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$$CCR^{OM}: \varphi_p^* = Min \sum_{i=1}^{m} v_i x_{ip}$$
subject to (1)
$$\sum_{r=1}^{s} u_{rp} - \sum_{i=1}^{m} v_i x_{ij} \le 0;\ j = 1,2,\dots,n.$$
$$\sum_{r=1}^{s} u_{rp} = 1.$$
$$u_r, v_i \ge 0;\ r = 1,2,\dots,s; i = 1,2,\dots,m$$

In the optimal solution, values u_r^* and v_i^* are the weights attributed to each unit of outputs and inputs, respectively. It is defined that when $E_p^* = 1$, then DMU_p is efficient. The efficiency of p^{th} decision making unit in CCR-O is obtained by $E_p^* = \frac{1}{\varphi_p^*}$.

Sometimes, many DMUs are efficient in which complete ranking of DMUs is not possible. One of efficient techniques for complete ranking of DMUs proposed by Andersen and Petersen (1993) as Model (2).

$$CCR^{OM}: \varphi_p^* = Min \sum_{i=1}^{m} v_i x_{ip}$$
subject to (2)
$$\sum_{r=1}^{s} u_{rp} - \sum_{i=1}^{m} v_i x_{ij} \le 0;\ j = 1,2,\dots,n, j \ne p.$$
$$\sum_{r=1}^{s} u_{rp} = 1.$$
$$u_r, v_i \ge 0;\ r = 1,2,\dots,s; i = 1,2,\dots,m$$

4. CASE STUDY

Eco-innovation studies integrate economics, management and environmental sciences (Crespi et al., 2016). Most countries (if not all) focus on eco-innovations and included it in regulations and policies, particularly after the global downturn of 2008-2009 (EEA, 2014). Based on the OECD Council Meeting at Ministerial Level (MCM) in June 2009, OECD countries agreed to develop and extend the "Green Growth Strategy" to improve economic growth by considering sustainability (OECD, 2009a).

For this end, OECD countries are expected to significantly reduce energy use, pollutions and waste and improve their eco-efficiency. Evaluating performance of OECD countries in light of eco-innovation can help them to focus on their weaknesses. Many indices can be considered in evaluating eco-innovation. This study emphasizes the most common indicators such as population and energy use (inputs) and knowledge workers, ecological sustainability and global innovation index (outputs). Data for this study (see Table 1) were collected from the report of The Global Innovation Index 2016 (Dutta et al., 2016) and www.worldbank.org.

Table 1. Data of OECD countries for eco-innovation analysis

OECD country	Population (m)	Energy use* (kg of oil equivalent) per $1,000 GDP (constant 2011 PPP)	Knowledge workers (%)	Ecological sustainability (%)	Global Innovation Index (%)
Australia	24	116.83	65.2	51.7	53.1
Austria	8.5	78.86	59.5	53.3	52.6
Belgium	11.3	108.72	68.1	44.8	52
Canada	35.9	156.05	53.9	41.7	54.7
Chile	17.9	91.92	44.5	44.5	38.4
Czech Republic	10.5	126.80	52.9	61.6	49.4
Denmark	5.7	62.01	67.7	57.9	58.8
Estonia	1.3	159.40	51.5	59	51.7
Finland	5.5	149.71	70.5	51.7	59.9
France	64.4	90.56	62.8	51.6	54
Germany	80.7	79.33	63.2	50.8	57.9
Greece	11	77.48	38.5	53.7	39.8
Hungary	9.9	89.05	40	58	44.7
Iceland	0.3	392.74	59.8	40.6	56
Ireland	4.7	52.70	60.3	61.2	59
Israel	8.1	83.31	60.5	50.9	52.3
Italy	59.7	66.49	45	69	47.2
Japan	126.6	89.87	63	52.6	54.5

Korea, Rep.	50.3	144.16	65.5	39.6	57.1
Luxembourg	0.6	68.71	61.3	50.8	57.1
Mexico	127	85.37	35	42.4	34.6
Netherlands	16.9	86.57	60.2	49.8	58.3
New Zealand	4.5	119.82	53.1	45.3	54.2
Norway	5.2	84.08	63.1	51.4	52
Poland	38.6	96.03	45.5	46.3	40.2
Portugal	10.3	71.41	45.3	58	46.4
Slovak Republic	5.4	99.12	41.9	62	41.7
Slovenia	2.1	107.10	61.5	55.9	46
Spain	46.1	71.11	49.4	64.8	49.2
Sweden	9.8	100.82	77.6	59.3	63.6
Switzerland	8.3	51.27	71	65.6	66.3
Turkey	78.7	76.74	32.8	42.1	39
United Kingdom	64.7	66.58	61.5	64.2	61.9
United States	321.8	123.29	63.8	42.8	61.4

*Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport. Since data of energy use for 2016 is not available and energy usage in 2014 is 4$ lesser than 2013, therefore we estimated energy use for 2016 by (energy use of 2014*0.96*0.96). Table 2 illustrates the efficiency score and ranking of OECD countries regarding eco-innovation.

Table 2. Efficiency score and ranking of OECD countries

OECD country	Objective value (φ_p^*)	Efficiency score (E_p^*)	Andersen-Petersen efficiency score (Rank)
Australia	2.481429	0.4029936	0.4029936 (28)
Austria	1.604755	0.62314808	0.62314808 (14)
Belgium	1.913229	0.52267658	0.52267658 (20)
Canada	3.689153	0.27106493	0.27106493 (34)
Chile	2.64296	0.37836365	0.37836365 (31)
Czech Republic	2.321607	0.43073612	0.43073612 (26)
Denmark	1.062281	0.9413705	0.9413705 (5)
Estonia	1.873105	0.5338729	0.5338729 (19)
Finland	2.085838	0.47942362	0.47942362 (25)
France	1.996971	0.5007584	0.5007584 (23)
Germany	1.738263	0.57528694	0.57528694 (16)
Greece	1.799382	0.55574636	0.55574636 (17)
Hungary	1.837874	0.54410694	0.54410694 (18)
Iceland	1	1	1.96147121 (2)
Ireland	1	1	1.1350895 (4)
Israel	1.620517	0.61708702	0.61708702 (15)
Italy	1.232957	0.81105829	0.81105829 (6)
Japan	1.975464	0.50621019	0.50621019 (22)
Korea, Rep.	3.047884	0.32809648	0.32809648 (33)
Luxembourg	1	1	2.6573214 (1)
Mexico	2.576202	0.38816832	0.38816832 (29)
Netherlands	1.920212	0.52077583	0.52077583 (21)
New Zealand	2.065673	0.48410373	0.48410373 (24)
Norway	1.416449	0.70599083	0.70599083 (9)
Poland	2.653789	0.37681971	0.37681971 (32)
Portugal	1.539997	0.64935191	0.64935191 (12)
Slovak Republic	1.565572	0.63874418	0.63874418 (13)
Slovenia	1.525799	0.65539432	0.65539432 (10)
Spain	1.404094	0.71220303	0.71220303 (8)
Sweden	1.528861	0.6540817	0.6540817 (11)
Switzerland	1	1	1.21028686 (3)
Turkey	2.332277	0.42876554	0.42876554 (27)
United Kingdom	1.326934	0.75361698	0.75361698 (7)
United States	2.596628	0.38511485	0.38511485 (30)

Findings show that 4 countries of Iceland, Ireland, Luxembourg and Switzerland have the highest efficiency score and are efficient. That is, they are extensively engaged in eco-innovation practices and can transform inputs into outputs better than other countries. For example, results of Model (1) for Ireland (DMU_{15}) are as Table 3.

Table 3. Optimal solution of CCR-O for Ireland

Variable	V1	V2	U1	U2	U3	Objective value (φ^*_{15})
Value	0.085698	0.011332	0.000007	0.016339	0.000001	1.000000

It is evident that in Ireland, population is more important than energy use for eco-innovation. On the other hand, ecological sustainability with the weight of 0.1633987 is central for eco-innovation whilst knowledge workers and global innovation index have the second and third places, respectively. The same analysis for Australia reveals that energy use and knowledge workers are most significant for its eco-innovation. The reference set for Australia is Switzerland. Since Australia is not efficient, it should emphasize ecological sustainability and global innovation. By benchmarking against Switzerland, the main weakness of Australia is low value of GDP/unit of energy use. It seems that policy makers and economists in Australia must set strategies for better utilization of energy resources. Also, for improving ecological sustainability, they should consider the environment more closely since a lower portion of GDP in Australia (in comparison with Switzerland) spent on environment protection.

5. CONCLUSION

There is much evidence that climate change and negative impact of environmental pollutions have endangered human communities globally. In order to avoid and combat these negative impacts, countries must consider ecology and innovate mechanisms, tools and industries to promote their eco-efficiency. Performance evaluation enables entities to compare themselves with high performance ones and to improve capabilities to overcome weaknesses. This paper investigated eco-innovation of OECD countries using data envelopment analysis. Many indicators can be used for evaluating eco-innovation but in this paper five factors were considered because of their high importance in eco-innovation and sustainability. Findings show that Switzerland, Ireland, Iceland and Luxembourg are eco-innovative therefore other OECD countries must benchmark these ones to improve their own eco-innovation. This paper focused on outputs. Future studies can be devoted to input-oriented DEA models to evaluate eco-innovation of countries.

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REVEALING GREENWASHING: A CONSUMERS' PERSPECTIVE

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ABSTRACT

A significant problem arising in discursive green marketing practices is the growth of greenwashing; companies providing irrelevant, exaggerated or false information regarding a product's sustainable qualities. This has given rise to a number of issues yet has so far fallen short of being rigorously investigated. In this study, focus group discussions are used to provide one of the first assessments of the impact of greenwashing on consumers. The aim of the study is to gain an initial understanding of consumers' evaluation of different corporate green marketing messages both before and after disclosing greenwashing strategies used in the messages, as well as how this affects their perception towards the brands and their purchase intention. The findings from five focus group discussions indicate that the source of the message, eco-labels, brand perception and brand knowledge have a great influence on the perceived credibility of the message. The impact on buying behaviour of disclosing greenwashing strategies is influenced by a number of factors but even in cases where it does not directly result in a change of buying behaviour, consumers felt that being made aware of greenwashing was important to their overall decision making process. More importantly, from a practical tenacity, this research shows evidence that greenwashing influences credibility and opens avenues for further research.

KEYWORDS

Green Marketing, Greenwashing, Focus Groups, Consumers' Perspective.

1. INTRODUCTION

The environmental revolution starting in the early 1990s has led to an increase in green marketing practices (TerraChoice, 2010). While green marketing can help consumers make better-informed product choices, it is also a strong marketing tool for companies to create product differentiation based on sustainability-related positioning. Some companies capitalising on green marketing opportunities have been found to be making deceptive or misleading green claims. These deceptive or misleading claims often cannot be distinguished from genuine claims. For example, arguments such as *100% natural*, *recyclable*, *biodegradable* and *chemical free* are often used in an exaggerated manner when they may in fact be false or trivial and simply masquerading as a proxy for credentials of actual environmental significance. Deceptive green marketing, referred to as greenwashing, is defined as irrelevant, exaggerated or false information regarding a product's sustainable qualities. Research has shown it occurs on a large global scale (Baum, 2012, TerraChoice, 2010, Dai et al., 2014). Companies get involved in greenwashing practices for reasons such as increasing their sales and market share. To curb these practices governments worldwide developed guidelines such as the Green Guides by the United States' Federal Trade Commission, the Australian Consumer Law by the Australian Competition & Consumer Commission and the United Kingdom's Green Claims Code by the Advertising Standards Authority. Unfortunately, enforcement of these guidelines is limited (Delmas and Cuerel Burbano, 2011) and the compliance for global brands is made more difficult by differences in guidelines and regulations between countries. Greenwashing exploits consumers' genuine environmental concerns which creates problems such as limiting consumers' ability to make actual environmentally friendly decisions or generating confusion and scepticism towards all products promoting green credentials, including those that are genuinely more environmentally friendly. Greenwashing has a greater societal cost than other deceptive marketing practices; it not only affects consumers and companies but the environment as a whole. Ultimately, greenwashing threatens the progress of real improvements to sustainability.

Research to date in the area of greenwashing has mainly focused on describing deceptive or questionable green marketing practices (Peattie and Crane, 2005), providing recommendations for companies on decreasing greenwashing or avoiding ambiguous green advertising (Davis, 1993, Delmas and Cuerel Burbano, 2011), naming different types of greenwashing (e.g. Laufer, 2003, Peattie and Crane, 2005, Carlson et al., 1993), and discussing regulation around green marketing (e.g. Coppolecchia, 2009, Nehme and Adams, 2012). The majority of empirical research is quantitative in nature consisting of content analyses investigating the amount and types of greenwashing (e.g. Carlson et al., 1993, Fernando et al., 2014). Other quantitative empirical research tends to focus on green marketing with greenwashing being a subset such as survey questionnaires investigating consumers' scepticism towards green advertising (Matthes and Wonneberger, 2014, Do Paço and Reis, 2012) or experiments that investigate the use of labels, claims and imagery and their persuasiveness and trustworthiness (Atkinson and Rosenthal, 2014, Parguel et al., 2015). Few qualitative studies mention greenwashing but they do not involve explicitly disclosing greenwashing and its impact on consumers (Atkinson, 2013, Hoek et al., 2013). The current study specifically explores the impact of greenwashing from a consumers' perspective as their behaviour plays an important role in the move towards a greener marketplace. There is a significant gap in the literature on greenwashing as it is seldom investigated by itself. To the author's knowledge, greenwashing practices are not revealed nor the effect this has on consumers' behaviour or brand perception has been explored. Thus, the aim of this study is to investigate greenwashing through exploratory research on green marketing messages and consumers' responses.

This study looks at green marketing communication messages in Australia. Choice, Australia's largest consumer organization, surveyed non-food items from three different supermarket chains in 2008 and found that only three of the 630 environmental claims made on packaging could be substantiated (Beder, 2009). Similarly, TerraChoice Environmental Marketing (TerraChoice), a Canadian-based environmental marketing agency, surveyed seven Australian stores in 2008 and 2009 and found that only five products out of the 866 products that made environmental claims did not engage in some form of greenwash (TerraChoice, 2010). Data from later date has not shown signs of major improvement (Pearse, 2014).

The purpose of this paper is to gain an initial understanding of young Australian consumers and their responses towards different types of environmental marketing messages and greenwashing practices. The research is of an exploratory nature and its results will be a first step towards understanding consumers' evaluation of different corporate green marketing messages and the effect of disclosing greenwashing on both perception towards the brands used in the study as well as how it affects their purchase intention. The following research questions are formulated for this study.

1. How are green marketing messages viewed in terms of: (a) Source of message (b) Meaning (c) Trustworthiness and (d) Intention to buy

2. What changes in participants' perception of the marketing messages and their intention to buy can be observed after revealing the greenwashing strategies and their relevance or veracity?

2. METHODOLOGY

This study is directed towards pragmatism, focusing on the outcomes of the research rather than the antecedent conditions (Creswell, 2013). As stated by Powell (2001) "to a pragmatist, the mandate of science is not to find truth or reality, the existence of which are perpetually in dispute, but to facilitate human problem-solving" (p. 884), it is focused on solving problems in the "real world". Greenwashing is a real world problem affecting the real world (i.e. people, animals and the environment) and there is no clear solution yet. Pragmatism is not committed to one system of philosophy and reality, the truth is what works at the time and admits that research always occurs in different contexts, i.e. social, historical and political.

The study used focus group discussions with young Australian consumers, a segment considered to be more socially, cultural, ethically and environmentally involved than other consumer segments. This group of consumers grew up in a sophisticated media and computer landscape, are considered tech savvy, updated with global information and able to access the internet for information at any time (Bucic et al., 2012, Lee, 2008, Phillips and Stanton, 2004). The sampling strategy used for this study was homogeneous sampling as it is a useful method for focus group discussions. Homogeneous sampling gives the possibility to focus, to reduce and to simplify the study and facilitates group interviewing (Creswell, 2013). Participants were undergraduate marketing students, aged between 19 and 25 years old and from a major Australian university. They have an affiliation with marketing and therefore expected to hold a more observed and critical view towards marketing messages. They were approached during one of their classes and asked to voluntarily participate after ethics clearance was sought. The focus group method was chosen as it is a good method for gaining initial insight into new or poorly understood phenomena, in this case consumers' perspective of greenwashing. In addition, focus group discussions were the preferred method because of the group interaction. To a certain degree information processing and decision making takes place subconsciously and habitually, especially in the case of fast moving consumer goods (FMCG). Answering questions or responding to answers from either the focus group leader or other participants could lead to the development of thoughts or perceptions the participant was not aware of yet. By comparing the different viewpoints of the participants, allowing discussion between participants, motivation and underlying thoughts could be examined. Moreover, according to Morgan (1993) focus group discussions eventually lead to insight into both the range of opinions and the circumstances that lead to one respond rather than another.

A pre-test was conducted to review the comprehensibility of the questions, the presentation of the marketing messages used and to test the overall format of the interview. Subsequently, focus group discussions were held until saturation was reached, leading to five focus groups with a total of 42 participants. The participants were shown three types of real marketing messages, varying from packaging to advertisements. This was done because there might be a difference in perception towards green marketing whether it is communicated through an advertisement or through packaging. Real marketing messages were used for this study to being able to investigate participants' underlying thoughts and perceptions about brands and companies. Using real marketing messages meant that the messages portraying environmental issues needed to be classified as such. Banerjee et al. (1995) developed an analytical framework to establish whether an advertisement is classified as environmental or not. It needs to fit one or more of the following criteria: explicitly or implicitly brace the product with the physical environment, promote a sustainable lifestyle with or without a product and present a corporate image of environmental responsibility. After confirming the marketing messages selected use environmentally focused arguments the next step was determining whether the messages are suspected of greenwashing. There are many overlapping terms and definitions in the academic literature to identify different types of greenwashing (Carlson et al., 1993; Laufer, 2003; Peattie and Crane, 2005). However, TerraChoice's (2010) seven sins of greenwashing comprise of the most comprehensible and detailed overview of different types of deceptive green marketing. Their seven sins: no proof, vagueness, worshipping false labels, hidden trade-off, irrelevance, lesser of two evils and fibbing are widely known and cited in academic literature to identify different types of greenwashing (e.g. Lyon and Maxwell, 2011, Chen and Chang, 2013). The marketing messages chosen were from FMCG and available at the supermarket leading to a high possibility that the consumers were aware of the actual messages and products. Eventually three marketing messages of three well-known brands in Australia were used (Appendix A).

The marketing message of a global soft drink company introducing a new natural and healthier product was suspected of the sin of vagueness. Its promotion featured green imagery and a term like *natural* is too broad and not defined in the advertisement. Using vague terms is a common way of greenwashing and therefore important to include in the study (Cummins et al., 2014). The same reasoning applies to using the second marketing message, which is suspected of the sin of hidden trade-off, meaning the brand is marketed as green on a specific set of attributes without considering other aspects that might be environmentally damaging. The second marketing message consists of solely the packaging of a green home-brand from a major Australian supermarket. The suspicion of greenwashing was not about the product itself, it was about the company behind the product. The supermarket owning the green home-brand is part of a conglomerate that has major investments in the mining industry. The green product line gives the strong impression that the supermarket is contributing to protecting the environment, a position that is not in alignment with the million tonnes of coal that the parent company produces annually. The third marketing message used was an advertisement of a large tuna company making a claim of being dolphin safe. Canned tuna is a popular product in Australia as it is affordable, convenient and a healthy snack and therefore included in the study (Choice, 2016). Australian tinned tuna is fished in the Western Pacific where anglers generally do not catch dolphins. It does not specify that the by-catch contains no other species like turtles, sharks and other fish (Choice, 2016). Thus, boasting about the safety of one species is an irrelevant distraction and the advertisement is suspected of the sin of irrelevance.

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3. RESULTS

The data was analysed by both the software program Nvivo for digital analysis and manually by the researcher. In general the combination of both the digital and the manual method is seen as deriving the best results (Welsh, 2002). The manual transcription analysis was performed by highlighting key points in the texts and searching for common replies from participants within a focus group and across focus groups. Analysing data in Nvivo occurs via coding. The type of coding chosen for this study was "open coding", which means summarising text by the use of concise code. There is a continuous interplay between data collection and analysis; a consistent process of comparing and contrasting the qualitative data in the search for similarities and differences (Glaser and Strauss, 1967). Coding of the data was done by setting up nodes or categories for developing themes. These are organised in hierarchies, moving from a general topic (parent node) to more specific topics (child nodes). The transcription of the first focus group discussion was used to set up parent nodes and child nodes for answers of participants according to the questions asked, their views and perceptions towards the marketing messages and the revelation of the greenwashing practices. Each following group discussion adds onto the existing parent and child nodes or causes the categories to become even more specific, or to develop a new parent or child node.

Most of the participants gave environment related responses when asked what thoughts arise when viewing the marketing messages. Animal friendliness, health, safety, corporate social responsibility and ethics were other topics that arose in participants' minds when looking at the marketing messages. Although these terms somewhat overlap they are not the same, implying that the use of green marketing does not mean the same to everyone.

When asked about trustworthiness quite a number of participants consider themselves as sceptical of marketing messages while at the same time assuming that those messages need to contain some sort of basic truth. To them a marketing message can be a bit exaggerated, but the information in the messages needs to rely on truth. The green home-brand and the tuna brand were seen as trustworthy with one having a recycled logo and the other a *dolphin safe* mark. The soft drink advertisement was seen as least trustful, because in the participants' view "X is always going to be unhealthy" (F5). In most of the participants' minds consumers are aware of this and understand that a soft drink product is never going to be natural and healthy. The marketing message was seen as obviously misleading by the participants and the doubtful information given by the company in terms of *healthier* and being *natural* seems to be taken for granted. One participant summed it up concisely by saying "People that drink X probably won't care whether it is from natural sources and got a little less sugar than the normal product and people who do care about that stuff won't be drinking X anyway" (F4). The participants' intention to buy was not necessarily related to the environmental aspect. This was only the case for the tuna brand because of its animal-friendly message visible in both the ad and on the side of the product. The reason for purchasing the soft drink was that at the time it was newly introduced to the market. For the green home-brand the main reason to purchase it was because it is a store brand and therefore expected to be cheap, plus it is recycled. In other words, in the range of low-cost products it was preferred because of the recycled aspect.

After disclosing the greenwashing information and explaining the specific sins the marketing messages were suspected of, the immediate responses could mainly be described as surprise or shock. Most of the participants did not expect that all these marketing messages were somehow misleading or not telling the complete truth. While discussing the question, there were only a few participants that expressed longer-term strong negative opinions towards the marketing messages and the companies behind them. After the greenwashing information had sunk in most participants somewhat changed their perception towards the disclosure of greenwashing practices. In their eyes, it became just another marketing strategy and there is something deceitful to almost all marketing messages of all companies. Overall, responses ranged from calling it "Shifty" (F1), mentioning "They're not lies, they're just exaggerating" (F2) to "All companies make these sort of claims" (F1). Looking at the specific marketing messages and brands, hardly anybody was surprised by the soft drink company advertisement. The participants did not expect it from the other two companies and therefore the negative responses were mainly targeted at the green home-brand and the tuna company. The participants in one of the focus groups mentioned that they were disappointed in the green home-brand, not knowing that the supermarket is part of a much bigger conglomerate with large investments in the mining industry. "You buy the greener version because you think it is better than the normal brand and then it turns out that the money from both goes to the same big mining investing company" (F3). Once the greenwashing practices were revealed, participants' responses were on a brand or company-level rather than product-level. Participants linked the greenwashing information to the initial impressions they held about the brands while discussing the impact of the greenwashing information, not the specific product portrayed in the marketing messages. Asked whether they would still consider purchasing the products the majority indicated yes. For some it depended on the price. Especially for the green home-brand price was an important decision factor; the product would be purchased only if it is not much more expensive than the normal home-brand. The tuna brand could lean on brand loyalty; its consumers were not likely to change simply because they like the brand. The impression was that if the purchase intention is not necessarily green, the greenwashing practices do not influence their purchase intentions. There were a few that might not buy the products mentioning "I probably think twice now" (F1) but in general participants agreed that it is undoable to take the background of for example the green home-brand into account. Once chosen to go to supermarket X, the rest of the information becomes irrelevant, defending themselves by saying that "You cannot investigate the company behind every product" (F4).

After the focus groups discussions were done the researcher was approached by multiple participants asking how to find out about greenwashing. They expressed their concerns when they found out that information about greenwashing is not easily available and accessible, especially not when taking into account that they have to investigate each product they buy. They uttered that if they would know more about greenwashing practices and if the information were more easily available, they would be able to make better decisions. Information seems important, because "If you don't know the whole picture you can never be sure whether you actually make the right decision" (F3).

4. DISCUSSION

The discussion section discusses the findings in relation to the research questions set up at the initial stage of the study (source of message, meaning, trustworthiness, intention to buy, changes in perception and changes in buying behaviour).

Source of message: The fact that most participants showed a tendency for their opinions to be influenced by their attitude towards the brand as a whole rather than just the actual marketing message shows the strength of brand influence and previous knowledge of products, brands and organisations. It was expected that people's opinions were strong because they saw existing brands that they probably would have seen and experienced at least at some point in their life. This was particularly evident with the tuna company; being considered a well-regarded and well-known brand by the participants led both users and non-users to believe the idea carried by the marketing message (that their products are animal friendly and safe).

Meaning: Even though green is a colour used to signify the environment, people also attach other meanings. All participants saw the same marketing messages but gave different responses when asked about the meaning behind the marketing message. Besides environment, animal friendliness, corporate social responsibility, ethics, safety and health were other aspects the participants related to green. Research often states that consumers buy green products because of their environmental consciousness (Van Birgelen et al., 2009, Schlegelmilch et al., 1996). The findings of this study show that not each consumer relates green exclusively to the environment. This could indicate that consumers have different motives to buy green which supports the idea that consumers do not necessarily buy a product based on its green credentials (Ottman et al., 2006). In other words, not every consumer who buys green products can be considered a green consumer.

Trustworthiness: There is research stating that consumers are becoming sceptical and critical towards labels (Chen and Chang, 2013, Gillespie, 2008) but the results of this study do not seem to support that. Claims such as *100% recycled* and *dolphin safe* were important indicators for trustworthiness. The major problem this creates is that consumers think they make the right decision while their purchase decisions will have profound effects to the environment or animals' well-being. The dolphin safe label for example seems to serve as an indicator for making an animal friendly decision, even though it clearly only states *dolphin safe* and the rest is left to be inferred by the consumer.

Intention to buy: Nobody explicitly stated they intended to buy the products because of the green claims. When weighing options out loud it became clear that price, quality, newness and likeability of a product are

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more important factors to base a purchase decision on than environmental attributes. The environmental friendliness aspect is rather seen as an extra benefit.

Changes in perception: Revealing the misleading information communicated by the major soft drink company did not surprise the participants and does not seem to harm the brand or the brand perception much. This was different for the other two products. Especially the green home-brand, build on being green, got some negative feedback. The product is sincere, however the fact that the money earned with the greener products ends up in the pocket of a large polluting company that uses it for non-environmental friendly investments was something none of the participants were aware of before it was revealed to them. The dolphin safe label in the tuna message was a meaningless label and even after revealing the greenwashing information one of the comments was "At least you know this one for sure is dolphin safe" (F2) showing how effective this technique can be.

Changes in buying behaviour: Participants in this study did not necessarily disregard products and brands when accused of greenwashing. In addition to that, the majority of participants said that knowing the companies behind these brands and marketing messages make false claims, give questionable information, or only base their marketing message on a single piece of information does not change their buying behaviour. The main reasons given for continuing to buy products from companies engaged in greenwashing is that it is simply too hard to investigate how green a company actually is, all companies do it so no point changing, but also it is not worth the trade-off because of their positive experience with the product or brand. Participants indicate that it is impossible to investigate every product, brand, company and umbrella organisation by themselves for each product they are considering purchasing. However, there is still a number of participants that argued that they would make better decisions if they had more information beforehand.

5. CONCLUSION

Greenwashing seems to be apparent in almost all marketing practices around environmental issues. Most research in the field of green marketing and greenwashing is done in a quantitative manner leading to clear quantifiable results. The findings of this study contribute to the body of knowledge as it is one of the few qualitative studies done in the area of greenwashing. It is one of the first studies that investigated the impact greenwashing has on consumers' perception and behaviour by revealing greenwashing practices used in real marketing messages. This exploratory research investigated the perceptions and thoughts of young consumers and future marketing professionals on different environmental marketing messages. Source of the message, labels, brand perception and brand knowledge seem to have a great influence on the credibility of a marketing message communicating green information. Labels proved to be particularly effective for persuading consumers, even after greenwashing practices were disclosed. After disclosing the greenwashing practices, brands not known for their environmental friendliness or ethical practices making misleading claims seem to suffer from less image damage than brands that use green credentials as their main flagship or are built on the idea of environmental friendliness and engage in greenwashing. Overall, there seems to be no change in buying behaviour, however provision of information seems key to make consumers more aware and have them make better informed decisions.

The results of this study have practical implications for companies as it shows that environmental messages still have a positive effect on consumers' perception of products and brands as well as their purchase intention. However, greenwashing does not seem to be beneficial for companies in the long run. To further reduce incentives for companies to greenwash, public policy and government regulations should prevent greenwashed marketing messages from reaching the market. Currently there is no specific Australian legislation that regulates greenwashing (Nehme and Adams, 2012). Section 18 of the Australian Consumer Law (ACL), describing misleading or deceptive conduct, and Section 29 about false or misleading misinterpretations should be considered when companies make environmental claims (ACCC, 2011). This regulation does not prevent greenwashing practices happening on a large scale with companies exploiting the grey area between misleading (deliberately or not) and outright lying: information in environmental marketing messages is often not necessarily false, but merely exaggerated or trivial. Clear enforceable guidelines should be set in place to assure consumers they are able to make an informed decision.

As this study was one of the first of its kind and exploratory in nature; more research is needed to both verify the results and elaborate on the findings. This research was conducted by means of a student-sample, future research could verify the findings on a broader sample. This study used real marketing messages from three brands known in Australia. Each message was suspected of a different form of greenwashing based on the seven sins developed by TerraChoice. Future research could include all seven types of greenwashing and more thoroughly investigate whether there is a difference in consumer perception toward these different types, the base for potential differences and explore the opportunity of levelling the seven sins i.e. make them measurable. Influence of brand knowledge and experience had not been investigated in the field of greenwashing but proved to be of great influence. There was an example of a non-green brand and one example of a greener brand included into this study. Future research is needed to investigate whether a brand is judged more or less harshly by consumers for greenwashing depending on how dominant green marketing is in their overall branding strategy. The findings also show that not every consumer who buys green products can be considered a green consumer. It is important to further investigate the underlying motivations (e.g. animal friendliness, sustainability, health) and the depth of these motivations (e.g. level of environmental awareness) as the response towards greenwashing might differ based on the type of motivations consumers hold. When motivations of consumers are more clear and their response towards greenwashing is understood, provision of information about greenwashing can be adjusted accordingly.

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APPENDIX A

Figure 1. Global soft drink company

Figure 2. Green home-brand

Figure 3. Large tuna company

BENCHMARKING ANTHROPOGENIC HEAVY METALS EMISSIONS: AUSTRALIAN AND GLOBAL URBAN ENVIRONMENTAL HEALTH RISK BASED INDICATORS OF SUSTAINABILITY

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ABSTRACT

In Australia, the impacts of urbanisation and human activity are evident in increased waste generation and the emissions of metals into the air, land or water. Metals that have accumulated in urban soils almost exclusively anthropogenically can persist for long periods in the environment. Anthropogenic waste emissions containing heavy metals are a significant exposure pathway for urban soils. The purpose of this paper is to present indicators of sustainability for assessing the environmental health risk from exposure of urban soils to anthropogenic waste emissions containing lead, copper, zinc and chromium. By benchmarking urban surface soil concentrations of these four metals against Australian and international Soil Standards, a data set of indicators of sustainability can be construed for evaluating the potential long-term environmental health risks posed by continued exposure of urban soils to heavy metals.

KEYWORDS

Heavy metals, benchmarking, urban soils, sustainable development (SD), environmental health indicators, anthropogenic emissions

1. INTRODUCTION

The present study focuses on the chemical dimension of soil quality. Soil contamination is a significant threat to sustainable soil management (European Commission, 2002a, 2006) and impacts the social and economic well-being of societies (Jónsson et al, 2016). A 'healthy' environment is defined on the basis of environmental risk factors by the World Health Organisation (WHO): 'Environmental risk factors, such as air, water and soil pollution, chemical exposures, climate change, and ultraviolet radiation, contribute to more than 100 diseases and injuries' (WHO, 2016). Human and environmental health are coupled; human health and well-being cannot be considered in isolation of the environment: 'An estimated 12.6 million people died as a result of living or working in an *unhealthy* environment in 2012 – nearly 1 in 4 of total global deaths' (WHO, 2016). The aphorism that human and environmental well-being are 'coupled' applies to resource consumption and economic growth; societal activities (creating 'economic gains') reliant on resource consumption (with attendant waste emissions) to sustain economic growth are inextricably coupled (Daly, 1995; El Serafy, 2006).

In 1987 the members of the World Commission on Environment and Development (WCED) perceived humanity's predicament at the time to be sufficiently dire as to issue the warning that 'the same processes that have produced these gains have given rise to trends that the planet and its people cannot long bear' (WECD, 1987, p.12). Since the issue of this 'warning' almost 30 years ago, background (natural) levels of metals including lead (Pb), copper (Cu), zinc (Zn) and chromium (Cr) in air, water and soil have increased by anthropogenic flows of metals into the ecosphere by waste disposal and other societal activities (Hamon et al, 2004). Establishing background concentration for heavy metals has been difficult owing to many decades (and centuries) of anthropogenic release of metals (Hamon et al, 2004). Regional and urban background metal concentrations in Australia are essential data for gauging pollution levels and signaling need for intervention when environmental and human health thresholds are reached (NEPM, 2013).

Major anthropogenic airborne sources of lead Pb, Cu, Zn and Cr pollution occur via direct emission or loss into the ecosphere (European Commission, 2002b). The hexavalent (Cr-VI) form of chromium, which is toxic by inhalation and has been classified as a Class A inhalation carcinogen (IARC, 1990) and, environmentally speaking, Cr(VI) compounds are generally considered the most toxic (Shanker et al, 2005; Zayed and Terry, 2003). Major anthropogenic sources of atmospheric Cr(VI) are presented in Table 1. Windblown dusts contaminated with heavy metals (including the Cr-VI species of chromium) emanating from urban soils are a significant source of emissions to air in urban environments.

Table 1. Top 20 sources of chromium emissions to air, land and water in Australia (1999-2014)

Rank	Source
1.	Aeroplanes
2.	Basic Ferrous Metal Manufacturing
3.	Basic Non-Ferrous Metal Manufacturing
4.	Burning (fuel red., regen., agric.)/ Wildfires
5.	Cement, Lime, Plaster and Concrete Product Manufacturing
6.	Ceramic Product Manufacturing
7.	Coal Mining
8.	Commercial Shipping/Boating
9.	Electricity Generation
10.	Fuel Combustion - sub reporting threshold facilities
11.	Gaseous fuel burning (domestic)
12.	Lawn Mowing
13.	Metal Ore Mining
14.	Motor Vehicles
15.	Other Transport Equipment Manufacturing
16.	Paved/ Unpaved Roads
17.	Pulp, Paper and Paperboard Manufacturing
18.	Recreational Boating
19.	Water Transport Support Services
20.	Windblown Dust

Source: (NPI, 2016).

Notes: -For National Pollutant Inventory (NPI) reporting purposes, emissions are defined as the release of an NPI substance to the environment whether in pure form or contained in other matter and/or in solid, liquid or gaseous form. It includes the release of substances to the environment from landfill, sewage treatment plants and tailings dams (National Pollutant Inventory, DEH, 2006-07 Report, p.18).

-Approximately $75x10^3$ tonnes of chromium is emitted globally into the atmosphere annually by these sources with approximately one-third occurring as the Cr(VI) species (Kieber et al, 2002; Pacyna and Nriagu, 1988).

1.1 Geochemical Indicators: Rationale for the Study

Global urban and rural soil investigations have shown that anthropogenic waste outputs contaminate soil in cities including: Minneapolis, USA (Mielke et al, 1984); Berlin, Germany (Birke and Rauch, 1997; Mekiffer et al, 2000); Aberdeen, Scotland (Paterson et al, 1996); Wolverhampton, England (Hooker et al, 1996; Bridge et al, 1997); Birmingham, England (Wang et al, 1997); Tallinn, Estonia (Bityukova et al, 2000); Trondheim, Norway (Ottesen and Langedal, 2001); Karlsruhe, Germany (Norra et al, 2001; Norra and Stuben, 2003); Gainesville and Miami, Florida, USA (Chirenje et al, 2003); Gibraltar (Mesilio et al, 2003); Newcastle upon Tyne, England (Pless-Mulloli et al, 2004); the Totley suburb of Sheffield, England (Knight, 2004); and Seville, Spain (Madrid et al, 2004).

These geochemical studies have focused on soil contamination of large cities with particular emphasis on metals such as Pb, mercury (Hg), Cu and Zn. There is a paucity of research on the environmental health risks of atmospheric deposition of Cr(VI) and long-term accumulation in the ecosphere, particularly urban soil studies of Cr(VI) contamination with accompanying human health risk based indicators of sustainability. This study aims to address this research gap by a systematic evaluation of extant data on anthropogenic accumulation of Pb, Cu, Zn, Cr and Cr(VI) in urban soils and positing a data set of environmental health risk indicators (vis-a-vis urban soil studies) by benchmarking geochemical data (Pb, Cu. Zn and Cr soil concentrations) in 13 cities against Australian (NEPM, 2013) and international (CCME, 1999; CEPA, 2005) Soil Standards.

2. METHOD FOR DEVELOPING INDICATORS OF SUSTAINABILITY

Table 2 summarises the geochemical studies used for calculating environmental health risk indicator scores for Pb, Cu, Zn and Cr.

Table 2. Australian and global geochemical studies used for calculating health risk indicator scores for Pb, Cu, Zn and Cr

	Study	Author(s)
Australia	Sydney (estuary catchment)	[a]Birch & Vanderhayden, 2011
	Iron Cove sub-catchment	Snowdon and Birch 2004
	Homebush Bay sub-catchment	[b]Hodge, 2002
	Parramatta sub-catchment	[c]Olmos, 2004
	Wollongong City area	Beavington, 1973
Global	Seoul, Vietnam	Chon et al, 1995
	Danang–Hoian Area, Vietnam	Thuy et al, 2000
	Berlin metropolitan area	Birke and Rauch, 1997
	Great Britain	Culbard et al,1988
	Oslo, Norway	Tijhuis et al, 2002
	Xuzhou, China	Wang and Qin 2007
	Madrid, Spain	De Miguel et al. 1998
	Glasgow, Scotland	Gibson and Farmer 1986

[a]Birch & Vanderhayden, 2011; soil metal concentrations shown for 50th percentile, normalised
[b]Unpublished study by Hodge (2002) data cited in Birch and Vanderhayden (2011)
[c]Unpublished study by Olmos (2004) data cited in Birch and Vanderhayden (2011)

2.1 Principles and Precepts of Sustainable Development

Sustainable development (SD) translates into a series of 'precepts' that should be followed to prevent both the decline in the quantity and quality of 'natural stocks' including soils (Lawn, 2006). Holmberg et al (1996) formulated indicators underpinned by four principles 'that should be fulfilled by a sustainable society'. The principles are:

Precept 3: The rate of high entropy waste generation should not exceed the ecosphere's waste assimilative capacity (Lawn, 2006)
Principles 1-2: Substances extracted from the lithosphere must not systematically accumulate in the ecosphere**;** and society-produced substances must not systematically accumulate in the ecosphere (Holmberg & Eriksson, 1996**;** Azar et al, 1996).

These principles and precepts alone do not directly make provision for 'measuring' the 'sustainable development' of a nation; they provide parameters for indicators and measures to be formulated. For the purpose of facilitating the development of environmental risk indicators as measures of SD in Australia and globally, a conflation of precept 3 (Lawn, 2006) and principles 1 and 2 will be the reference for formulating indicator scores for the four elements. A conflation of the sustainability principles and precept leads to the following formulation:

Formulation 1
The sum of the anthropogenic emissions and the natural flows from the lithosphere to the ecosphere should not exceed the ecosphere's waste assimilative capacity.

2.2 Method for Establishing Background (Natural) Levels of Cu, Pb, Zn, Cr

Table 3 shows: the background ranges used for calculating indicators; presents Australian and international Soil Standards Health Investigation Levels (HILs) data; and provides three sets of background ranges posited by different authors (Berkman, 1989; Hamon et al, 2004; Shanker et al, 2005; Zayed and Terry, 2003).

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Table 3. Benchmarking 13 geochemical studies of soil metal concentrations against soil standards

Metal	Soil Standard			[d]Background (Natural) ranges (N_n)			[h]Geochemical Study (anthropogenic flows) (A_{1-13})												
	[a]NEPM	[b]CCME	[c]CEPA	[e](N_1)	[f](N_2)	[g](N_3)	1	2	3	4	5	6	7	8	9	10	11	12	13
Cu	1000	63	3000	2-100	<70	-	60	170	81	74	343	84	90	43	54	32	38	72	97
Pb	300	140	80	2-200	<40	-	150	1069	227	217	21	240	84	78	240	56	43	161	216
Zn	7000	200	23000	10-300	<130	-	259	927	281	341	82	271	153	159	260	160	144	210	207
Cr	-	-	-	5-1000	-	65	[i]50.0	-	-	-	-	-	[i]92.2	-	-	[i]32.5	[i]78.4	[i]74.7	-
Cr(VI)	100	0.4	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes: -All metal soil concentrations are mean concentrations shown as mg/kg.
[a]Australian Soil Investigation Standard (Residential HIL A) (NEPM, 2013)
[b]Canadian Standard for residential soil (CCME, 1999)
[c]Californian Standard for residential soil (CEPA, 2010)
[d]Background ranges are natural (***N$_n$***) environmental flows. Values shown account for natural flows of the element from weathering and volcanic eruptions
[e] (Berkman, 1989)
[f](Hamon et al, 2004)**.** Background ranges posited by Hamon (et al, 2004) vary depending on iron (Fe) levels in soil; ***N$_2$*** ranges provided are for soils containing 10% Fe
[g](Shanker et al, 2005; Zayed and Terry, 2003). The mean background total chromium concentration of 65mg/kg is derived from US, Canadian, Japanese and Swedish soils
[h]Metal concentrations are anthropogenic (***A$_1$***) environmental flows determined from the 13 soil studies in Table 2.
[i]Total chromium (non-speciated) concentration shown.
Geochemical studies: 1 (Birch & Vanderhayden, 2011); 2 (Snowdon & Birch 2004); 3 (Hodge, 2002); 4 (Olmos, 2004); 5 (Beavington, 1973); 6 (Chon et al, 1995); 7 (Thuy et al, 2000); 8 (Birke & Rauch, 1997); 9 (Culbard et al, 1988); 10 (Tijhuis et al, 2002); 11 (Wang & Qin, 2007); 12 (De Miguel et al, 1998); 13 (Gibson & Farmer 1986)

2.3 Method for Creating Environmental Health Risk Indicators

Environmental health risk indicator scores I_1, I_2 and I_3 are calculated as anthropogenic metal flows from the lithosphere to the ecosphere relative to the corresponding background ranges N_1, N_2 and N_3. The relationship between the flow of elements from the lithosphere into the technosphere, and from the technosphere into the ecosphere can be shown as:

$$I_{(1,2,3)} = A_{(1\ldots13)} / N_{(1,2,3)} \qquad \text{(Equation 1)}$$

Where ***I***= Indicator score; ***A***=Anthropogenic flows (based on geochemical studies measuring soil metal concentrations in mg/kg-see Table 2); and ***N***=Natural flows (based on data sets positing naturally occurring background soil metal concentrations in mg/kg**-** see Table 3) (Construed from Azar et al, 1996).

If the indicator scores calculated from geochemical data for the cities in Table 2 are greater than unity, the 'conditions for sustainability' embedded in formulation 1 are not met; the inference being:

If $I_{N1(1\ldots13)}$, $I_{N2(1\ldots13)}$ ***and*** $I_{N3(1\ldots13)}$ *scores are >1,* ***then*** *the current rate of anthropogenic outputs and deposition in the ecosphere of Pb, Cu, Zn and Cr is not sustainable in those cities (and the risk to human health vis-à-vis contaminated soils is increased through continued exposure to Pb, Cu, Zn and Cr through anthropogenic release into the ecosphere in those cities).*

3. FINDINGS AND DISCUSSION

Table 4 shows environmental health indicator scores $I_{N1\ (1\ldots13)}$, $I_{N2\ (1\ldots13)}$ and $I_{N3\ (1\ldots13)}$ derived from urban surface soil levels of Pb, Cu, Zn and Cr and Cr(VI) relative to background levels. The indicators in Table 4 lie in the range 0.32-26.72; the wide range is due to the Iron Cove sub-catchment determination for the metal Pb (26.72 mg/kg) being an outlier (Snowdon and Birch, 2004). Where the indicators in Table 4 are equal to unity, then the present soil metal concentrations are sustainable (the conditions for SD embedded in formulation 1 are met) posing less risk to soil contamination in urban environments. Indicator scores of greater than unity indicate metal accumulation in the environment at a rate that is greater than the attendant assimilative capacity of the environment; the inference drawn here is continued contamination of urban soils with Pb, Cu, Zn and Cr and Cr(VI) is not sustainable (the conditions for SD embedded in formulation 1are not been met). Environmental risk is proportional to the indicator score; indicator scores orders of magnitude greater than unity are evident for several studies: the Iron Cove sub-catchment study indicating levels of Zn>1($I_{2(2)}$=7.13) and Pb>1($I_{1(2)}$=5.35) (Snowdon and Birch 2004); the Wollongong study indicating levels of Cu >1 ($I_{1(e)}$=3.43) (Beavington,1973); the Madrid Study indicating levels of Pb>1 ($I_{2(12)}$=4.03) (De Miguel et al,1998); and the Glasgow study indicating levels of Pb>1 ($I_{2(13)}$=5.40) (Gibson and Farmer,1986).

The indicator scores in Table 4 reveal: the conditions for SD embedded in formulation 1 have not been met for 90% of the cities on the basis of N_2 (Hamon et al, 2004) background levels for Pb and Zn; and environmental health indicator scores of greater than unity are observed for 12 of the 13 cities on the basis of N_2 background concentrations. On the basis of N_1 background concentrations, 6 cities (Sydney, estuary catchment); Danang–Hoian Area, Vietnam; Berlin metropolitan area; Oslo, Norway; Xuzhou, China; and Madrid, Spain) met the conditions for SD in formulation 1 when assessed for Pb, Cu and Zn.

Table 4. Environmental Health Risk Indicator Scores

Study	Cu			Pb			Zn			Cr		
	$I_1=A_1/N_1$	$I_2=A_1/N_2$	$I_3=A_1/N_3$	$I_1=A_1/N_1$	$I_2=A_1/N_2$	$I_3=A_1/N_3$	$I_1=A_1/N_1$	$I_2=A_1/N_2$	$I_3=A_1/N_3$	$I_1=A_1/N_1$	$I_2=A_1/N_2$	$I_3=A_1/N_3$
1	0.60	0.86	-	0.75	3.75	-	0.86	1.99	-	-	-	0.77
2	1.70	2.43	-	5.35	[a]26.72	-	3.09	7.13	-	-	-	-
3	0.81	1.16	-	1.14	5.68	-	0.94	2.16	-	-	-	-
4	0.74	1.06	-	1.09	5.43	-	1.14	2.62	-	-	-	-
5	3.43	4.90	-	0.11	0.53	-	0.27	0.63	-	-	-	-
6	0.84	1.20	-	1.20	6.00	-	0.90	2.08	-	-	-	-
7	0.90	1.29	-	0.42	2.10	-	0.51	1.18	-	-	-	1.42
8	0.43	0.61	-	0.39	1.95	-	0.53	1.22	-	-	-	-
9	0.54	0.77	-	1.20	6.00	-	0.87	2.00	-	-	-	-
10	0.32	0.46	-	0.28	1.40	-	0.53	2.00	-	-	-	0.50
11	0.38	0.54	-	0.22	1.08	-	0.48	1.11	-	-	-	1.21
12	0.72	1.03	-	0.81	4.03	-	0.70	1.62	-	-	-	1.15
13	0.97	1.39	-	1.08	5.40	-	0.69	1.59	-	-	-	-

Notes: -Sustainability indicators ('scores') determined by benchmarking geochemical investigations of soil metal concentrations against NEPM, CCME and CEPA Soil Standards.
-Indicator scores greater than unity are shaded. An Indicator scores of >1 specifies that the conditions for sustainable development embedded in Formulations 1 and 2 have not been met.
[a]An outlier (Snowdon and Birch, 2004).

Table 5 summarises the percentage of geochemical studies showing metal concentrations that are greater than unity relative to the posited background ranges; 15.4%, 46.2% and 15.4% of geochemical studies showed that anthropogenic flows for Pb, Cu and Zn were greater than natural flows when compared to N_1 background data (Berkman, 1989). Environmental health indicator scores for 61.5%, 92.3% and 92.3% of geochemical studies showed that anthropogenic flows for Pb, Cu and Zn respectively were greater than natural flows when compared against N_2 background data (Hamon et al, 2004).

Table 5. Percentage of geochemical studies within standard EIL limits and background range

Metal	% of geochemical studies showing metal concentrations > NEPM standard	% of geochemical studies showing metal concentrations > CCME standard	% of geochemical studies showing metal concentrations > CEPA standard	% of geochemical studies showing metal concentrations > N_1	% of geochemical studies showing metal concentrations > N_2	% of geochemical studies showing metal concentrations > N_3
Cu	0	61.5	0	15.4	61.5	
Pb	7.7	61.5	61.5	46.2	92.3	
Zn	0	61.5	0	15.4	92.3	
Cr	-	-	-	-	-	60
[a]Cr(VI)	0	100	100	-	-	

[a]Environmental health risk indicator scores ($I_3=A_1/N_3$ in Table 4) for Cr are used as a basis for benchmarking Cr(VI) against the Soil Standards. The resulting percentages are based on the probability that approximately one-third of the atmospheric releases of chromium are believed to be in the hexavalent form (Kieber et al, 2002; Pacyna and Nriagu, 1988).

Construing the indicator scores (Table 4) and the percentage of geochemical studies outside of EIL limits (Table 5) together, the inferences drawn from these data are: Pb, Cu and Zn from the lithosphere have spread at a rate which has given rise to a systematic increase in the ecosphere thereby implicating the soils in all of the cities forming part of this study; and on the basis of N_3 background levels, Cr(VI) has spread in cities located in Australia, Vitenam, Norway, China and Spain at a rate that potentially increases risk to human health through long-term exposure and inhalation of Cr(VI) contaminated dust.

4. CONCLUSION AND RECOMMENDATIONS

In Australia there is a significant challenge with the quality of voluntarily reported data from emitters of Cr and the other metals. Cr(VI) emissions and total chromium data have large associated errors due to the reliance on emitters measuring and reporting quantitative data accurately. According to the Australian National Pollutant Inventory (NPI, 2016), the total emissions levels are lower than actual due to: the suspected low capture rate (possibly up to 50%) of potential industry emitters voluntarily reporting data; and out of date diffuse source estimates and lack of uniform reporting of diffuse sources by jurisdictions (DEH, 2005). It is therefore highly probable that the environmental health indicator scores posited are lower than actual.

Under reporting of emissions has implications for human health as it is plausible that soil contamination with Cr(VI) and Pb, when benchmarked against Soil Standards (CCME, 1999; CEPA, 2010) have exceeded human toxicity thresholds in cities including Sydney (Birch & Vanderhayden, 2011), Hoi An in Vietnam (Thuy et al, 2000), Xuzhou in China (Wang and Qin, 2007) and Madrid in Spain (De Miguel et al, 1998).

The findings of this study recommend a deeper analysis and review of the current approach to the Australian Human Health Risk Assessment framework (NEPM, 2013).The current definition of 'potential impact' is too broad; a narrow, specific definition accompanied by provisions in the NEPM framework for the long-term environmental monitoring of air and soil Cr(VI) levels would benefit urban populations given that continued anthropogenic release of such metals is unlikely to decrease significantly soon. Goodland and Daly (1996) conflate equity and sustainability; 'sustainability indeed has an element of not harming the future' (Goodland and Daly, 1996). Between 1996–97 and 2006–07, the volume of waste produced per person in Australia grew at an average annual rate of 5.4%. Australians generated approximately 1,200kg of waste per person in 1996–97 and this increased to 2,100kg per person in 2006–07 (Productivity Commission, 2006).

On the basis of the data indicating a trend of continually increasing consumption and waste generation, the impacts of continued anthropogenic release of Pb, Cu, Zn and Cr, and particularly Pb and Cr(VI), into the ecosphere are likely to result in long-term harm, especially to the health of future generation dwelling in urban areas. Further research is recommended to assess the long-term environmental and human health impacts of urban soil contamination with heavy metals.

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Short Papers

RACING TO THE FUTURE: SECURITY IN THE GIGABIT RACE?

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ABSTRACT

This research seeks to identify the differing national perspectives towards security and the 'gigabit race' as those nations transition to their next generation broadband networks. Its aim is to critically appraise the rationales for their existing digital security frameworks in order to determine whether (and what) Australia can learn from the alternative legislative and regulatory frameworks implemented by key nations and trading blocks. This paper provides an outline of the research motivation and direction. The research will fill major knowledge gaps about the motivation, rationale, legal and social implementation, and impacts on security for next generation broadband networks and will inform the development of digital security and communications policies.

KEYWORDS

Telecommunications regulation, cyber security, public policy, privacy, NBN

1. INTRODUCTION

Investment by government, industry and business in broadband networks and digital systems has been increasing consistently. Attempts to protect digital security can be seen in a variety of jurisdictions. The effectiveness those measures in practice will depend on the specific jurisdiction and its method of regulation (Lodder, 2013). The rapid and radical transformation of society's participation in the digital era (Cradduck, 2015) has led to efforts by the Australian federal government to legislate for improved digital security while seeking to facilitate investment in next generation telecommunication networks. However, as Guadamuz (2011) observed "[n]ational laws tend to treat the subject of cybercrime by a combination of the application of old norms and the enactment of new legislation" (p.179). An understanding of the relationship between public policy, legislation, regulation and technical outcomes has failed to keep pace with the rapid changes to global telecommunication markets and governments' responses to technological changes during the 'gigabit race'. The significant advances driving the development of digital networks, in Australia and globally, have resulted in the need for improved digital security and telecommunications capabilities (Gregory & Glance, 2013). Stakeholders have a variety of perspectives as to how to achieve the inter-related outcomes necessary for success to be achieved, however, it is often far from certain whether any success in fact was achieved (Gregory, 2014). Decisions affecting digital security and telecommunications infrastructure provision based on technical, legal and or investment criteria can be identified. Absent from the literature, however, is an evaluation of the inter-relationship between digital security, consumer protection and provider satisfaction.

This research investigates the different perspectives for security in the 'gigabit race' as nations transition to next generation broadband networks. Data collection and modeling of the major knowledge gaps has required studying the linkages between motivation, rationale, legal and social implementation and impacts of security for next generation broadband networks; and the development of communications policies. The research project has commenced and initial work into the development of a data structure and model is presented in the paper. The paper concludes by identifying matters requiring further consideration.

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2. RESEARCH CONTEXT

The Seoul Declaration for the Future of the Internet Economy 2008 provided its signatories (including Australia) would "promote ubiquitous access to ICT networks and services enabling widespread participation in the Internet Economy". However, the resulting increased ease of access to the internet brought with it increased risks of breaches of security and privacy (Cradduck & McCullagh, 2007). Importantly, an individual's perception of their level of security and privacy when engaging on the internet influences their desire to engage (Cradduck, 2015). Therefore, if those perceptions are negative, this will impact negatively upon Australia's place in the 'gigabit race'. As Cutler (2008) identified a "lack of user trust in the security of the transactions" will act as inhibitor of e-Commerce (Cutler 2008, 62). In order to encourage participation, and ensure Australia's position in the gigabit race, issues of reliability of access and security must be addressed (OECD, 2013). It is for this and similar reasons that digital security and privacy concerns receive international attention (OECD, 2013a; Ponemon Institute, 2011).

As Kee et al. (2011) observed "where the conduct to be regulated or the product to be protected will have an impact on the international stage, it … requires collective policy making" (Kee et al. 2011, 175). As the global digital network is a combination of the many national networks decisions made in one jurisdiction regarding digital security and telecommunications functionality will affect other jurisdictions. This is particularly relevant to issues of security due to the transnational nature of cybercrimes (Guadamuz, 2011). This means that, in order for Australia to affect a smooth transition to its next generation networks, there is a need to study the different jurisdictional perspectives and approaches being utilised to legislate and implement digital security. Significantly whether, and what, Australia can learn from the legislative and regulatory frameworks implemented by key nations and trading partners to support their various digital security policies during the 'gigabit race' has yet to be critically examined.

3. AIM AND METHODOLOGY

This research aims to contribute to the public policy and national security discourse in two significant ways. First, by examining the motivations for security and broadband related legislation internationally it will create a single source of empirical data that can made available as a resource for use by other researchers. Second, by undertaking a comparison between the collated data and the Australia position it will identify how the approaches to security can be used appropriately to influence investment in infrastructure.

The research methodology consists of three interrelated and concurrent research strands – 1. policy and technology; 2. policy, legislative and regulatory; and 3. theoretical, policy, legal and technical model generation. These will be used to address issues arising from the identified empirical and theoretical knowledge gaps. These strands draw on the linkages between the data items shown in Table 1, an understanding of the history that led to the legislative, regulatory, technical and competitive landscapes.

Table 1. Data Items and Categories

Item	Category	Item	Category
Telecommunications Act	Legislation	Privacy Regulator	Regulation
Companies Act	Legislation	Competition Regulator	Regulation
Consumer Protection Act	Legislation	Telecommunications Ombudsman	Regulation
Competition Act	Legislation	Industry Technical Regulator	Regulation
Data Breach Notification Act	Legislation	Telecommunications Department	Government
Privacy Act	Legislation	Consumer Advocate	Industry funded
Trade Practices Act	Legislation	Universal Service	Industry funded
		Industry Peak Body	Industry funded

The *policy and technology* research strand will undertake a review of public policy decisions, related technical outcomes and field research. In this way the authors will develop an understanding of why different approaches have been adopted in the targeted nations and trading blocks for digital security and telecommunications during the 'gigabit race'.

The disparate global policy, legislative and regulatory digital security and telecommunications environments have resulted in a range of affects that require investigation, or to identify best practice, in the formation of government policies, legislation and regulations. The *policy, legislative and regulatory* research strand will engage the authors in extensive field research. This will include interviews and surveys in order to determine governance, international relationships, innovations and political motivations. Drawing on Australian and international data gathered during the research project, the authors will contribute to theoretical and applied knowledge in this area. In the *theoretical, policy, legal and technical model generation* research strand, the authors will develop new theoretical, policy and technical evaluative models which can be used to guide an understanding of the broader implications and motivations resulting in different global approaches to digital security and telecommunications in the 'gigabit race'.

3.1 Limitations

The authors acknowledge a significant research constraint regarding available data and information. Information regarding national digital security strategies is fragmented and often not publically available. The limited availability of such information results in a constrained view of digital security and telecommunications and impedes upon any researchers' ability to accurately identify related themes.

4. DISCUSSION

A consideration of the available literature identifies two knowledge gaps. The first gap is empirical as currently there is no single reference source available that provides an overview, or in-depth case study, of the global perspectives of digital security and telecommunications. This renders an assessment of the benefits or otherwise of the effectiveness of various approach/es to digital security and telecommunications during the 'gigabit race' more difficult to achieve. Available information about national digital security strategies also is fragmented and there is a lack of a cohesive structure regarding domestic laws. An impact is that stakeholders cannot readily identify best practices, nor measure how legislation will affect digital security and telecommunications or whether there will be any associated affect on consumer and business confidence. The second gap is theoretical. In policy terms is there a conceptual framework that ties together the different aspects of providing digital security and telecommunications. However, the theoretical model will need to provide the basis for an analysis on the effectiveness of legislation and technology change. It also will need to be able to be use to identify what is being affected or being missed as a result of current policy decision-making processes. To investigate the theoretical knowledge gap it will be necessary to conceptualize the provision of digital security and telecommunications as a disruption to, rather than an extension of, existing systems and infrastructure. In this way it will be possible to critically examine arguments that policy, legislation and technology can bring together the right mix to achieve improved outcomes (Kee et al., 2011).

Politics has a significant role in domestic policies (Reed, 2012). As such, the development of international policy into appropriate domestic laws is not straightforward and can be exacerbated by the political divide in many countries (Gulati & Yates, 2012). This is perhaps more clearly seen in those jurisdictions where the process of creating legislation is a competitive, rather than collaborative, process as the sides seek to best position their own interests (Inoue, 2007). There is a need therefore for any domestic laws and policies to "address the tension that exists between the efficiency benefits for a uniform global policy and the variation in national and regional tastes for different politics" (Metcalf & Weisbach, 2012, 110). Also important is the need to ensure the ability of policy and law to develop as easily as society does. Internationally, divergent domestic government policies, and often changes of government, mean that at any given time one jurisdiction can view the need for regulation of the same activity in numerous, and potentially inconsistent ways (De Vos, 2010). This affects the existence, and content, of policy and related legislation (Dutton & Blank, 2011). Issues of digital security, privacy and confidentiality of information, remain inextricably linked (Swink, 2001). Mechanisms to encourage individual's participation absent overcoming any lack of individual digital skills (EC, 2015) merely increase concerns for both digital security and privacy generally. For the immediate future as well as beyond there are a variety of matters that policy makers need to consider and act upon. In particular cybersecurity for countries, as well as security issues for businesses and individuals will become more essential (OECD, 2013a). Importantly considerations of what is appropriate regulation is linked with what are appropriate enforcement powers and what is the necessary level of funding required in order to enable those powers to be effectively used (OECD, 2013).

5. CONCLUSION

The global nature of digital security and telecommunications warrants investigation of the various alternate approaches and the development of a model that provides a framework for understanding the inter-related public policy, legislation and technology solutions. The existing provision of digital security and telecommunications during the 'gigabit race' is a significant investment with rationales currently grounded in the public good, notions of fairness and market failure in terms of access to an essential resource. However, while these rationales may be justified in terms of promoting market competition, it is the authors' contention that, currently, there is no effective measure for global or Australian outcomes and as such these rationales may not fully capture the intent of the legislation or technical solutions being implemented.

By clarifying these problems, this research is the start of the first in-depth study of global perspectives on digital security and telecommunications focused on public policy, legislation and technology. This research is on the cusp of public policy, crime policy and computer communication network research as the authors by theorising the digital security and the 'gigabit race' as a form of constrained digital security focus on the impacts to Australian and global infrastructure. The research will significantly expand the current literature, as well it will create a new evidence base, which may be accessed by other researchers.

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AN E-LEARNING SYSTEM WITH MR FOR EXPERIMENTS INVOLVING CIRCUIT CONSTRUCTION TO CONTROL A ROBOT

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ABSTRACT

This paper proposes a novel e-Learning system for technological experiments involving electronic circuit-construction and controlling robot motion that are necessary in the field of technology. The proposed system performs automated recognition of circuit images transmitted from individual learners and automatically supplies the learner with virtual measurement and circuit behavior simulation using a segmentation-based mixed reality (MR) technique. The proposed system is advantageous in terms of practical use because learners with insufficient or no circuit components, and/or measurement instruments, and/or experimental facilities can use the proposed system to learn about the construction of practical circuits embedded in robots and to evaluate the motion of a robot. The usefulness of the proposed system was evaluated by analyzing circuits and robots constructed by 15 university students in a class. Results showing positive responses, which indicate the usefulness of the proposed system, were obtained from all the students.

KEYWORDS

e-Learning for technological experiments; electronic circuit; robot design and building; SPICE; mixed reality

1. INTRODUCTION

The field of technology education necessitates teaching and learning of basic theories and experiments involving construction of electronic circuits. Education on robotics invention is important for students to acquire an extensive knowledge of technologies such as electronic circuits and system control. Therefore, experiments involving robot design and construction are effective in developing student faculties in the study of technologies, and increase the motivation of students towards engineering. Recently, several education support systems have been developed to improve student understanding of robotics (Behrens, 2010; Gómez-de-Gabriel, 2011; Huang, 2013; Takemura 2013). However, conventional education systems on robotics are insufficient for usage in technical education due to the following disadvantages:

- Electronic circuits equipped in a robot are either ready-made or black boxes. Therefore, it is not possible for students to learn about the design and construction of electronic circuits used in the robot.
- Conventional systems cannot cope with the wide variety of circuits designed and constructed by individual learners because they are ready-made tools and can only be applied for specific educational purposes within a subject area.
- Conventional systems require the use of proprietary software to learn about circuits and robotics.
- Conventional systems cannot be applied to or are sufficient for e-Learning for experiments.

To overcome the fore-mentioned disadvantages of conventional systems, this paper proposes a novel e-Learning system for experiments involving the construction of electronic circuits and robots. The proposed system possesses the following technological novelties:

(1) An education system for experiments to learn about the design and construction of practical circuits with sensors and DC motors that are embedded in a line tracer robot.

(2) A learning tool that can simulate the operation of circuits and the motion of robots using a mixed reality (MR) technique. This technique is effective for e-Learning in experiments because a student can learn about robot behavior without the need to constructing an entire physical robot.

(3) The proposed system is composed of web-based learning tools, and thus it is not necessary for learners to use proprietary software.

This proposed system was evaluated by undergraduate experimenters in an actual class at Tokyo University of Agriculture and Technology (TUAT).

2. METHODOLOGY

The proposed system consists of individual users' systems (learners' computers) and a remote analysis system. Individual learners can use their computers and learn about the construction of circuits embedded in robots and the behavior of the robots. Subsections 2.1–2.4 describe the technological features of the proposed e-Learning systems. In this paper, experiments involving the construction of practical circuits embedded in a line tracer evaluated the proposed e-Learning system. The line tracer is a robot that can detect the edge of a thick black line on a white floor and move along the black line.

2.1 Function for Supporting Circuit Construction

The proposed e-Learning system provides learners (system users) with necessary guides, such as circuit diagrams and specifications, to design and construct circuits. The proposed system enables learners to choose between three learning modes, namely a virtual circuit-construction mode (VCM), a real circuit-construction mode (RCM), and a mixed mode, based on the required purpose or environment (Takemura, 2013).

The VCM can be used by learners with insufficient physical circuit components or measurement equipments or facilities (e.g., laboratories). The VCM enables individual learners to use a preferred graphics editor to place virtual circuit components on a circuit-board image downloaded via a computer network and to draw colored lines to indicate connections between the virtual circuit components. Therefore, the proposed system does not require the use of proprietary graphics software. The VCM allows learners to observe and measure the characteristics of the constructed circuit by using the virtual measurement function of the system (described later in Section 2.2).

The RCM can be used by learners with physical components necessary for circuit construction. If RCM users do not possess the instruments for operating and measuring the circuit, then the RCM allows learners to observe and measure the characteristics of the constructed circuit by using the virtual measurement function of the system.

The mixed mode of the proposed system can translate a circuit image consisting of both real and virtual circuit components. This mode is useful for a learner who wants to construct a large scale circuit but without sufficient physical circuit-components necessary to construct the complete circuit.

2.2 Function for Image Processing and Circuit Translation into SPICE

The function for image processing and circuit translation performs an important role in the preprocessing of the proposed segmentation-based MR technique. Learners complete circuit construction using the function described in Section 2.1 and transmit the circuit images to the remote analysis system. In order to automatically recognize circuit construction, the analysis system performs image processing in the following manner:

(1) The remote analysis system binarizes the circuit image and detects the connecting terminals. Based on the array of the detected connecting terminals, the circuit image inclination is corrected and the circuit size is measured.

(2) Pattern matching between the circuit image and the circuit components available in the system analysis database is used by the analysis system to discriminate the circuit components (e.g.; devices and wirings) and the nodes of the connected components.

Based on the result of the circuit recognition, the analysis system performs an automated translation of the circuit into a general circuit-description language (simulation program integrated circuit emphasis, SPICE) (Rabaey). The SPICE information obtained from this automated translation process enables the simulation of the circuit operation, and individual learners can observe circuit characteristics without the instruments for operating and measuring their circuits (Takemura, 2013). Additionally, the analysis system can indicate the presence and location of incorrect parts in a learner's circuit by checking any differences that exist between the SPICE information in correct circuits and those constructed by a learner. The SPICE translation is based on automated circuit recognition, and therefore the system can cope with various structures, such as circuit component layouts and wirings of circuits made by individual learners.

2.3 Function for Simulation Using the Segmentation-based MR

Based on the information of circuit structures obtained from the segmentation process (as described in 2.2(2)), the proposed system can simulate circuit operation and robot motion using the segmentation-based MR technique. The MR is a view that comprises of the virtual reality (VR) and the augmented reality (AR). VR is a computer-generated view that is similar to a real environment. AR is an augmented view comprising physical contents and additional computer-generated information such as computer graphics or moving image data. The MR technique used in the proposed system generates a moving image that simulates the operation of a circuit or the behavior of a robot. The simulated moving image obtained from the MR supplies learners with simulated moving images at accurate sizes and positions in the circuit image based on the segmentation result.

2.4 Improvement of the Usability

The proposed system can detect incorrect parts in circuit images based on the automated SPICE translation (described in Section 2.2). To improve the usability of the preceding system (Takemura, 2013), the system sends messages to individual learners during experiments and instructs them to check their results as follows:

- When incorrect components or faulty wiring are detected from a circuit image, the analysis system indicates the errors and instructs the learner to check and correct the errors.
- When the analysis system detects a serious error (e.g., a short circuit or inappropriate power supply), the system sends a critical warning to the learner to correct the incorrect part.
- The analysis system requests the learner to check whether the simulated behavior of the constructed circuit corresponds to their specifications.

2.5 Experimental Methodology

The proposed system was evaluated by 15 undergraduate students in an actual class at TUAT. To evaluate the usability of each function in the proposed e-Learning system, the students were asked to perform the following experiments to construct the circuits used in a line-tracer robot:

(1) Each learner downloaded the necessary guides to design and construct circuits, such as circuit diagrams and specifications, from the Internet.

(2) The VCM function of the proposed system was used by each learner to create the virtual circuit of a line-tracer robot including an optical sensor and a DC motor. Each learner checked whether the e-Learning system indicated warnings or incorrect parts in their circuits. If warnings and incorrect parts were indicated, then the learner corrected these parts in accordance with the advice provided by the system and completed the circuit construction.

(3) Each learner observed the motion of the constructed circuit using the VCM (illumination of LEDs and rotation of motors) from the MR simulation provided by the proposed system.

(4) The RCM function was used by each learner to create the physical circuit of the line-tracer robot. Each learner performed a check as to whether the e-Learning system indicated warnings or incorrect parts in their circuits. If warnings and incorrect parts were indicated, then the learner corrected these parts in accordance with the method described in (2).

(5) Each learner observed the motion of the circuit constructed using RCM (illumination of LEDs and rotation of motors) from the MR simulation.

(6) Applying the images of the constructed circuits, each learner designed and constructed the virtual line-tracer robot using the mixed mode function of the proposed system and observed the behavior of the robot from the MR simulation provided by the system.

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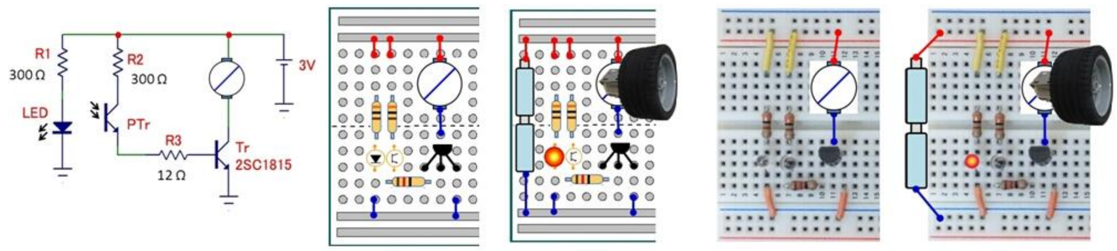
3. RESULTS AND DISCUSSION

Fifteen undergraduate students in an actual class evaluated the proposed system through experiments (1)–(6) as described in Section 2.5. Figure 1(a) shows the circuit diagram of a circuit used as part of a line tracer to be constructed. This circuit includes a DC motor and an optical sensor that consists of a LED and a phototransistor. This circuit controls the rotation of a wheel on a line-tracer robot. Figure 1(b) shows the circuit constructed by a learner using the VCM. After the learner connected correctly the additional virtual components (DC batteries) in the image of the constructed circuit (Figure 1(b)), the segmentation-based MR simulations of the illumination of the LED and the rotating wheel were automatically indicated at specific places that were discriminated using the image segmentation process (shown in Figure 1(c)). The output voltage obtained from SPICE simulation based on the automated circuit-translation process of the proposed system (as described in Section 2.2) was used to control the rotation speed of the wheel.

Figure 1(d) shows a circuit constructed by the same learner using the mixed mode. The learner constructed the circuit by connecting the physical circuit components that were provided with the exception of a DC motor. As shown in Figure 1(e), the learner connected the virtual circuit component (DC motor) instead of the insufficient physical component and completed the circuit construction using the mixed mode of the system. After connecting the virtual components (DC batteries) correctly in the image of the circuit constructed using the mixed mode, the MR simulation of a rotating wheel was obtained. The rotation speed of the wheel was controlled based on the output voltage obtained from SPICE simulation that was based on the automated circuit-translation process of the proposed system.



(a) (b) (c) (d) (e)

Figure 1. Circuit diagram of a line tracer to be constructed and the results of the experiment involving circuit construction and segmentation-based MR simulation (motor rotation): (a) Circuit diagram, (b) Virtual circuit constructed using the VCM, (c) MR-simulation of the constructed circuit (b), (d) constructed circuit using the mixed mode, and (e) MR-simulation of the constructed circuit (d)

Figures 2(a) and (b) show the lower and upper surfaces, respectively, of a line-tracer robot designed by the same learner using the mixed mode of the proposed system. As shown in Figure 2(a), a virtual circuit as well as a physical circuit was embedded in the virtual robot that was designed by the learner using a graphic editor. The proposed e-Learning system performed the image processing and circuit translation of the circuit image in the virtual robot and provided the learner with a moving image of the simulated behavior of the line-tracer robot as shown in Figure 2(c).

The students in the study evaluated the proposed e-Learning system. Positive responses were obtained from all the students and these indicated the usefulness and the effectiveness of the proposed system. Specifically, the following responses were obtained:

- This education system is useful because it enabled e-Learning with respect to topics such as circuit design and experiments involving the construction of practical circuits related to robotics.
- This e-Learning system is effective because the system can cope with various structures (layouts of circuit components and wirings) of the circuits constructed by individual users
- The e-Learning system used for virtual robot construction and simulation of the robot behavior is instructive because individual users can study practical circuits with sensors to control the behavior of the robots without the use of sufficient circuit components and proprietary software.

However, the responses also indicated a few technical disadvantages and suggestions for improvement; e.g., an educational system to study various types of robots, such as robot arms and humanoids, is expected.

(a) (b) (c)

Figure 2. Line-tracer robot designed using the mixed mode and the simulation result: (a) Lower surface of the designed line tracer, (b) Upper surface of the designed line tracer, and (c) Simulation of the motion of the designed line tracer

4. CONCLUSION

This paper proposes a novel e-Learning system for technical experiments involving the construction of practical electronic circuits and robotics using a segmentation-based MR technique. The proposed system consists of a learning system of circuit construction with sensors embedded in a robot and a MR-used simulation system to learn about the operation of the constructed circuit and the behavior of robots. The usefulness and effectiveness of the system was verified by the responses of 15 undergraduate students in a university class. Positive responses, which related to the usefulness and efficiency of the proposed system, were obtained from all the students. The following steps were necessary steps to practically implement the proposed system:

- Evaluation of the system by more experimenters.
- Enhancing the system to study more highly developed robots with plural sensors and motors such as humanoids.

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SIMULATIONS FOR CRISIS COMMUNICATION: THE USE OF SOCIAL MEDIA

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ABSTRACT

Simulations have been widely used in crisis and emergency communication for practitioners but have not reached classrooms in higher education. The purpose of this study was to investigate the effects that simulations using social media have on the learning of crisis communication among college students. To explore the effects, a real-time crisis simulation activity using social media is created for 132 undergraduate students enrolled at a business school. Both quantitative and qualitative data collected from pre- and post-simulation surveys are used to investigate the benefits of simulations on learning and identify the challenges the participants experienced.

KEYWORDS

Simulations, Role-Playing, Social Media, Crisis Communication, Higher Education

1. INTRODUCTION

Simulations are considered a powerful and effective tool for learning with great potentials for educational use and have been widely used in the higher education setting. It is defined as a representation of some phenomenon or activity that users learn about through interaction with the simulation (Alessi & Trollip, 2011). Using an interactive abstraction of simplification of environments or events of real life, simulations force learners to act upon in the given situation.

Two critical components of simulations are non-linear and dynamic structure and causal relationship between choice and outcomes. Simulations usually have multiple variables present in scenarios that are inter-related and each variable leads to a different outcome, which means that the situation that learners are placed at a given point is created by the choice that the learners have made previously. This dynamic and interactive nature of simulations rendered by the non-linear structure makes learners aware of freedom and control they have as well as responsibilities they should bear in their decision making. This further gives students an opportunity to reflect on the consequences and meaning of their decisions (Gary & Wood, 2011), and learn the need for broader perspectives and multifaceted approaches to problem-solving. Hence, simulations are an effective tool to teach skills and knowledge related to processes, decision-making, and problem-solving.

Positive effects of simulation-based learning have been accumulated in education literature. Prensky (2001); Aldrich (2005) argue that simulations stimulate enjoyment and motivation among learners which in returns enhances enjoyment in learning concepts. Simulations are found to foster collaboration among learners and voluntarily explore various options (Chakravorty & Franza, 2005). Others reported that critical thinking can be enhanced through simulations (Sportsman, et al, 2011). The challenges, unexpected or hidden factors, or unpredictable outcomes in real-life like situations in simulations will provide opportunities to learners to develop critical thinking skills through problem-solving experience. Simulations also teach decision skills (Alinier, Hunt, Gordon. & Harwood, 2006; Bolt (2005): Aldrich (2005), and encourage the application of concepts learned from classroom to the given situation (Anderson & Lawton, 2004). Simulations also have positive effects among learners. Participants through observation and collaborative group process learn from knowledge, attitudes, and actions from one another (Keys, 1990).

Public relations and corporate communication fields have used crisis simulations in consulting and training of top management and employees with a series of crisis scenarios with differing levels of severity (Sellnow, Venette, & Veil, 2006). Through a simulation, the levels of knowledge of crisis and preparedness of the organization and its members are assessed, and the outcomes of the simulation create the awareness of potential risks and crises of the organization the sense of urgency for planning for crisis and emergency situations for all participants.

2. SIMULATIONS AND SOCIAL MEDIA

Social media are dramatically changing lives of everyone. From photos of food on Instagram (so-called food porn), to a YouTube video of a police shooting an unarmed man (South Carolina cop shooting, 2015), to tweets of an airplane crash (a plane crash in the Hudson River, 2009), to a Facebook page of humanitarian aid to Nepal (International Medical Corps, 2015), social media penetrated to every facet of individual life. No other media was so rapidly changing the way people communicate with others. Learners these days use social media on a daily basis for activities ranging from meeting and making friends, broadening personal networks, sharing ideas and opinions, creating contents, learning and teaching others, etc. However, higher learning education, and simulations in specific, has not fully incorporated social media into teaching and learning in a classroom.

Social media provides a free and easy way to disseminate large amounts of information to large groups of people very quickly and efficiently. Given the widespread of social media in crisis communication and the utility for information dissemination and communication with many stakeholders, simulations using social media are a perfect tool to teach crisis management and communication.

2.1 Research Questions

This study aims to examine the effects of simulations using social media on students' learning processes and outcomes of crisis management and communication such as satisfaction, engagement, understanding concepts, problem-solving skills, and instructor effectiveness. Besides benefits, this study will explore the challenges and difficulties that learners face during simulations. The past studies in simulations seem skewed towards exploring the benefits of SBL, largely ignoring negative effects on learning process and outcomes or challenges to learners. Understanding what learners went through during simulation helps educators design and prepare for more effective simulation programs. The non-linear structure of simulations may create confusion and frustration for learners, especially for those with low motivation, lack of understanding of situations, or prefer linear/sequential learning style. The research questions of this current study are as follows:

RQ1: What effects do simulations have on learners' satisfaction, engagement, and understanding the course concepts?

RQ2: What challenges do simulations pose to learners during the simulation?

3. METHOD

The week before the simulations, students will learn about crisis communication including the types of crisis communication (Benoit, 1995), crisis communication strategies (Coombs, 2007), and crisis communication planning (Coombs, 2014). The study will employ a real-time simulation where all students are assigned to specific roles. For this study, we developed a scenario about a food retail brand in a crisis due to a claim that the brand has been using slavery in production for many years. During the simulation activity, students are asked to 1) monitor the development of the crisis, 2) maintain communication with internal and external stakeholders, and 3) take any necessary actions at any time during the simulation. After the 60-minute simulation, students will give a press conference to the press (the instructor and the teaching assistants) at the broadcasting studio at the University, issuing the official statement of the company and engaging in Q&A session (30 minutes) with the press.

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3.1 Measurements

Two surveys will be used to collect the data from the participants. The pre-simulation survey measures the levels of social media proficiency, learning style, communication style, understanding of the crisis-related concepts, and attitudes toward simulations, which will be used as control variables. The post-simulation survey measures the levels of the perceived usefulness of simulations, engagement, and satisfaction. The survey also measures challenges that students experienced during the simulations by using qualitative feedback. All measures are adapted from existing studies or created to fit the study context. Using the data obtained from the pre- and post-simulation surveys, this study will examine the relationships among these variables using structural equation modeling (SEM).

3.2 Participants

Participants are 132 undergraduate students who are currently enrolled at a corporate communication course at a business school in Singapore. The participants will be divided into six sessions, about 22 students per session. The simulation will run one session at a time in a given week. About four students will be assigned to different teams such as CEO's office (one student will be assigned to the CEO), Corporate Communications, Investor Relations, Internal Communications, Government & Stakeholder Relations. Each team is in charge of managing the different stakeholder groups such as employees, media, investors and shareholders, government and legal authorities, consumers, retail stores, and suppliers, and is responsible for gathering any information from their stakeholders regarding the current crisis and maintaining constant communication with them. All teams are instructed to use various communication tools such as emails, the company's Intranet, telephone calls, and face-to-face meetings, and only Corporate Communication team is allowed to use additional social media sites such as Facebook and Twitter to keep these two social media as the official communication channel for the company. All social media comments, emails, news articles, and incoming calls will be made and fed to the students by a team of assistants.

3.3 The Simulation and Press Conference

The simulation starts with the CEO receives a message from his friend who tries to confirm the news article that claims the company has been using slavery and inhumane working conditions for workers at its food manufacturing facilities in Asia for many years. Then the CEO calls his/her team for verification of the story. In rapid succession, multiple articles reporting the claim begin to appear on major news sites, followed by posts and tweets on social media. A few minutes later, there are many calls from journalists for the company's official comments on this issue. One reporter says that he/she would like to interview the CEO about this issue. From this point onward, participants will receive various inputs such as emails, telephone calls, social media feeds, etc. Participants are asked to return requested outputs and deliverables using the communication tools. Table 1 shows a complete list of inputs during the simulation.

Table 1. Timeline for Crisis Communication Simulation

Time (minutes)	Event
0:00	CEO receives a message from his friend regarding the news article
1:00	CEO calls CEO office team for verification of the story
2:00	Multiple articles appear on major news sites
5:00	Social noise begins
9:00	Calls from journalists for comments, Requests for interviewing the CEO
10:00	Corporate Communication team convenes a meeting
13:00	New online article appears
17:00	New comments to that article start to appear
21:00	Amnesty calls for comments
25:00	Local branch office issues unapproved response on Twitter
27:00	CEO calls his team as he has just received a call from a journalist about the tweet.
27:00	Head of Operation emails technical information regarding the crisis.
29:00	New online article appears
31:00	Amnesty issues press release
35:00	Journalists start calling
35:00	Criticism escalates on social media
39:00	The new online article appears which contains customer boycott, Amnesty comment, and criticism toward the company.
42:00	Regulators call for information and comments
45:00	Facebook group appears: Anti-brand group
49:00	Employee in Brazil posts personal response on behalf of company
51:00	Labour rights group emails CEO about the employee's response
53:00	Share price tanks, trading suspension
57:00	Angry investor calls
60:00	Simulation ends. 10 minutes break before the press conference
70:00	Press-conference starts
100:00	Press-conference ends

4. EXPECTED RESULTS AND CONCLUSION

Clearly indicate advantages, limitations, and possible applications. In this paper, we will investigate, through the analysis of survey data, whether simulations using social media are effective learning tools for crisis communication in higher education. The results of this study will shed lights on our understanding of the benefits and challenges that simulations using social media produce to learners and can enlighten educators with practical knowledge about how to incorporate simulations using social media into classrooms.

It is expected that the simulations using social media will be viewed as educational, engaging, and satisfactory in learning crisis communication by participants. Immersed in the realistic setting of the simulations such as the scenario, the involved stakeholder groups, various inputs, and the evolution of the crisis, students will experience and appreciate the importance of action in preparing for crisis communication. Performing under time pressure will create unexpected effects to the whole experience. Some students may forget the basic communication rules or skills; others may experience frustration for having the difficulty of collaborating with various groups or being unable to keep up with information influx.

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SOCIAL NETWORKING FRAMEWORK FOR UNIVERSITIES IN SAUDI ARABIA

Sulaiman Alqahtani[1]

ABSTRACT

The interactive capacities of social networking instruments have unleashed a number of possibilities for enhancing teaching and learning in the higher education sector and many universities are engaged in harnessing the capabilities of these tools. While much valuable research has been conducted on this theme, scholarship has tended to be oriented towards academic practices and sample student populations derived from mainstream societies and countries; little research has been conducted into social networking uptake in higher education sectors in peripheral geo-cultural regions. This research aims to focus on Saudi Arabia in order to develop and assess a social networking framework for the use by Saudi Arabian universities. The main research outcome will be a social networking framework for higher education in Saudi Arabia which can be used by Government departments, funding bodies, university management, administrators and technical support departments for the benefit of teaching staff and learners.

KEYWORDS

Social Network, Web 2.0, Saudi Arabia, Higher Education

1. INTRODUCTION

Recent research describes and evaluates a multitude of trials and projects world-wide as providers strive for relevance in the eyes of their digitally conversant target market by incorporating social networking sites as pedagogical instruments (Conole et al. 2004; Jonnavithula & Tretiakov 2012; Tella, Alias & Ithnin 2009). While the current research is prolific, it is limited in two crucial areas: firstly, there is little extant research on systematic, top-down, wider scale usage of social networking as a tool within university pedagogies. Furthermore, most of the current literature references universities, students and pedagogical practices which derive from a "Western" mainstream and do not delve into what social networking might offer – and how it should be contextualized for - different teaching and learning cultures. Accordingly, this research aims to identify the factors which must be taken into account when developing a Social Networking Framework for higher education in Saudi Arabia.

2. BACKGROUND

This research focuses on instruments that are considered to be Web 2.0 technology such as wikis, blogs and media sharing sites under the umbrella term social networking. Foremost among Web 2.0 tools are social networking applications such as Facebook and Twitter. While they differ in terms of functionality, purpose and uses, such Web 2.0 or social networking tools are united by their interactive and user-centric capabilities.

2.1 Web 2.0 Tools in Higher Education

Higher education is considered a natural arena for the implementation of social networking technologies for two reasons: firstly, the uptake of social networking by "Digital Natives" (Prensky 2005), and secondly, the suitability of interactive technologies to the ends of higher education where creating, sharing and

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disseminating ideas in academic communities is of primary importance. Indeed, in recent times, universities and other higher education providers – at the level of individual practitioners or faculty-wide – have actively sought to deploy the functionalities of collaborative digital technologies in their teaching and learning methodologies and a nascent body of research has emerged. This research has focused on the ways in which emergent social networking technologies have the potential to reconfigure pedagogical practices, course delivery techniques and teacher-learner relationships in institutions of higher learning. Most of these pilot studies examine the pedagogical usages of Facebook, Twitter, wikis, blogs and other Web 2.0 applications. While not uniformly in support of social networking in higher education, most of this research heralds the benefits of technologically enhanced teaching and learning, particularly the ability of these platforms to provide the advantages of ubiquity, synchronicity and connectivity. These innate characteristics of social networking technologies are seen to support vital academic functions such as knowledge construction, sharing of ideas and resources and critical thinking (Acquisti & Gross 2006; Alkindi & Alhashmi 2012; Caruso & Salaway 2007; Chu & Meulemans 2008; Eberhardt 2007; Evans & Kilinc 2013; Godwin-Jones 2008; Greenhow & Robelia 2009; Hamid, Chang & Kurnia 2009; Muñoz & Towner 2011). Risks and pitfalls identified in these studies include issues of privacy, security and trust, lack of technological expertise in some user groups, time wasting, laziness and distractibility as well as reduced depth of thought and academic achievement (Boogart & Robert 2006; Çardak 2013; Grabmeier 2009; Khan 2009; Mesch 2009; Weiss 2013; Wilson 2009).

2.2 Web 2.0 Tools in Higher Education in Saudi Arabia

Saudi Arabia occupies an ironic position in relation to social networking in that the country is both highly traditional and permeated by Islamic precepts and practices, yet, especially in the case of its younger demographic, enthused about technological innovation. Recent reports suggest that there are more than 13 million users of digital applications in Saudi Arabia, with 51% of the population active on Twitter and 42% on Facebook (NourElDineDaaboul 2013). In regard to its national agenda of modernisation, Saudi Arabia is currently in the 9th phase of a series of five-year reform plans (2010 – 2014) and has dedicated considerable resources to the implementation of ICT-based teaching and learning in order to achieve objectives related to quality in its educational sector. However, information and communications technology initiatives in Saudi Arabia have been largely limited to more traditional forms of electronic engagement, such as delivery of online study materials and lectures, rather than the incorporation of more cutting-edge web technologies. Little published research is available to support enquiry into how Saudi college students perceive and make use of social networking or to what extent faculties incorporate social networking applications into their course delivery and pedagogical practices (Chaurasia, Asma & Ahmed 2011, p. 312). Of the handful of studies that do exist, many focus on “e-learning” or distance learning technologies and classic LMS tools as opposed to more contemporary collaborative Web 2.0 instruments (Al-Khalifa & Garcia 2013; Al-Otaibi 2011; Al-Saggaf 2004; Al Saif 2005; Alenezi, Abdulkarim & Veloo 2010; Almalki 2011). Other studies focus only on barriers to social networking in Saudi Arabia, including Internet access issues, gender equity, trust and privacy concerns, lack of Arabic language interfaces and user support documents for technological platforms and the predominance of in person and rote-learning styles (Al-Khalifa & Garcia 2013; Aljasir, Woodcock & Harrison 2012; Almalki 2011; Binsahl & Chang 2012; Chaurasia, Asma & Ahmed 2011; Sultan et al. 2012).

3. RESEARCH METHOD AND RESEARCH QUESTION

This study draws on both interpretative and “mixed” approaches: in so doing, the research in its first phase utilises focus groups to draw on the perspectives of stakeholders within the context of higher education in Saudi Arabia in order to arrive at a deeper understanding of what might constitute a suitable framework for incorporating social networking into the university curriculum. Furthermore, the research takes a mixed mode approach whereby the integration of quantitative methods adds to the depth and rigour of the subject under scrutiny. In this case, an online survey will be used and its results analysed according to Factor Analysis so as to achieve a more sophisticated and rigorous picture of what might constitute a successful set of factors for a framework for social networking within the context under investigation. Finally, this research aims to address and answer the following research question: What are the factors that must be considered for developing a social networking framework for higher education in Saudi Arabia?

4. RESEARCH OUTCOME

The proposed framework which has been developed for this research based on the literature review will then be subject to further examination and assessment through stakeholder feedback comprises a set of core factors which are believed to be crucial to the success of social networking as a pedagogical tool in Saudi Arabia. Firstly, it is suggested that the framework must contain a set of practical guidelines and suggestions, including visual representations. Secondly, a robust framework must include core functionalities which enable collaborative and interactive transactions between users within a design specification which caters for navigability, ease of use and optimal linkage mechanisms between "functional" spaces such as learner and teacher "spaces". Another core factor is a technological infrastructure that guarantees continuity and reliability of usage as well as high levels of support for end users. Finally, integral to the framework is the notion of a sound pedagogical framework in which user roles, teaching and learning paradigms and teaching and learning activities are well framed and understood. Surrounding these core factors, it is proposed that the framework needs to be adjusted to account for variables such as the socio-cultural context and how this defines social and gendered identity, teacher-learner roles as well as understandings about learning and knowledge construction. Allied to this, the framework needs to control for national factors such as investment in education as well as governmental stance on open source, web-based technologies, and organisational factors which may include the organisational culture of individual universities, flexibility of senior management and the way in which social networking may "fit" organisational objectives. In sum, the perspective of all stakeholders needs to inform the design and development of the framework which is the purpose of this research. This framework might prove to be a mapping guide to government departments, funding bodies, university management, administration and technical support teams involved in any future endeavour to integrate social networking within the higher sector in Saudi Arabia. By extension, students and teaching personnel would be advantaged by the inclusion of such technologies due to their potential to support key higher education teaching and learning tasks. Furthermore, the framework lends itself to application to other contexts in that it comprises a set of core factors as well as a set of surrounding, influential factors. This second set of factors can be analysed in the context of other socio-cultural, national and economic variables which then affect how core items are mobilised, altered, omitted or replaced in view of the surrounding influences for the country under consideration. In all, the study aims to identify the factors which will act as a blueprint for successful usage as Saudi Arabia consolidates itself economically, socially and educationally and aims towards higher standards of scholarship and innovation.

5. CONCLUSION

In conclusion, this research is in the early stages of identifying which factors might constitute a framework for the successful implementation of social networking into universities in Saudi Arabia. Thus far, the research has pinpointed a number of key critical points, derived from global literature on the role social networking can play in the pedagogical pursuits of higher education, and created an encompassing framework. Further investigation will now take place to refine the model so that Saudi Arabia is poised to benefit from a social networking system that foregrounds benefits and controls for risks.

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RETHINKING E-LEARNING MEDIA: WHAT HAPPENS WHEN STUDENT *LIKE* MEETS PROFESSOR *ME*?

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ABSTRACT

Today digital-device-outfitted Millennials comprise the majority of university students. Concern over these digital natives' tendency to perform lower than expected as a group in college after completing a commendable high school experience, has some eyeing character traits as a possible culprit. Conversely, university faculties are comprised primarily of Baby Boomers and older members who grew up in lower-tech, lesser-interactive-media environments. Higher education institutions have invested a lot of resources into facilitating the integration of digital technologies and best practices into the instructional processes, but how far has the professorial *Me* generation really advanced in comparison to our studious *Like* generation? Are we designing e-media effective enough for Millennials? This paper will analyze Pre-Millennials' text dependency and their resulting instructional media processes as a barrier to bridging the digital divide between higher-education and its incoming Millennial students.

KEYWORDS

E-learning; multimedia; media; generation; student; professor

1. INTRODUCTION

Although the birth years of any generation are not set in stone, this year many would agree that eighteen-year-old Millennials (a.k.a., Gen Y) are the majority population entering college as freshmen, with Post-Millennials only a few years behind them. The most avid users of technology, Millennials "are 'digital natives'—the only generation for which these new technologies are not something they've had to adapt to" (Pew Research Center, 2014). Our students have changed radically, they are no longer the people our educational system was designed to teach (Prensky, 2001). The characteristics of any given generation are rife with vast generalizations, often subject to conflicting viewpoints (Twenge, 2014; Koughan & Rushkoff, 2014), but a premise put forth in this paper is that we have an older generation designing and delivering instruction for a younger generation. This worked when we didn't have on-demand, instant access to information. In fact, the younger generation is now creating informational content for all eyes in the world who have Internet access. According to Beattie, Laliberté, & Oreopoulos (2016), today's youth entering college are experiencing significant dips in their track-record-proven academic productivity upon entering college. They cite non-academic character traits that make them either a thriver or diver as the predictor of college success. Divers are students whose first-year college GPA is far below expectations, have a high tendency to procrastinate, self-report cramming for exams, wait longer before starting assignments, are less conscientious, and express superficial goals. In contrast, thrivers exceed expectations, express more philanthropic goals, are purpose-driven, and are willing to study more hours per week to obtain a higher expected GPA. This isn't a novel occurrence if you reflect back upon other transition-impacting concerns that were addressed by higher education institutions including social connectedness, first-generation status, and availability of specialty-oriented academic support groups. The character-related reasons being investigated by Beattie, Laliberté, & Oreopoulos (2016) may well impact Millennials' post-secondary learning experience. I contend, however, that we also have a significant disconnect between the instructional media that works optimally for Millennials and the media experience we commonly offer in higher education. As instructors and designers of instructional content, we have to be certain that our efforts are resulting in optimum outcomes for students. Before looking at details of the instructional content it is important to compare and contrast the individuals involved in the higher education teaching and learning relationship.

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2. GENERATIONAL MEDIA

The quintessential professor and Millennial student are each prolific in their consumption and authorship of media, but in their own way. The college teen is more likely to implement a selfie stick or post a YouTube video as a means of documenting his or her daily accomplishments. A professor on the other hand may be caught left-swiping a New York Times article, or agonizing over the nth text edit to his or her pending publication. For the millennial "the same brain circuits that are activated by eating chocolate and winning money are activated when teenagers see large numbers of "likes" on their own photos or the photos of peers in a social network" (Wolpert, 2016, para. 1). Current trends suggest that Baby Boomers are just as obsessed with technology as Millennials, but through different avenues. Despite popular belief, the majority of compulsive social media checkers are adults, with the highest usage observed in those between the ages of 25 and 54 (Chang, 2015). The key variance is the type of use. A Millennial is more apt to partake in text-independent uses such as Snapchat, Instagram, posting their mood on Facebook, or catching up with the latest YouTube pop culture icons' video posting. A Boomer, conversely, is more likely to partake in a text-dependent medium such as checking email during mealtime, incessantly following a Twitter thread, or monitor any number of Blogs or news feeds. Regardless of the media-type preference, or the motivation for engaging media, additional strides to close the distance between the types and design of media generational groups prefer may help students with the secondary to post-secondary education environment transition. Today's average college grad has spent fewer than 5,000 hours of their lives reading, but over 10,000 hours playing video games and 20,000 hours watching TV (Prensky, 2001). Younger adults are leading the way in increased mobility with digital devices, and take advantage of a wider range of functions (Zickuhr, 2011). Millennials' ownership of cell phones, laptops, and game consoles surpasses other generations. They are more likely to have more digital devices. Although TV is the most heavily consumed platform of all generations, digital device usage is gaining steam with younger consumers (Nielsen, 2016). In fact, Smartphone and TV-connected device usage by Millennials leaves other generations behind. As a result of the ubiquitous technological environment and the sheer volume of their interaction with it, today's students think and process information fundamentally differently from their predecessors with the differences go far further and deeper than most educators suspect or realize (Prensky, 2001). There is a failure to build a bridge between the technological world Millennials live in and the classrooms we expect them to learn in (Considine, Horton, & Moorman, 2009).

3. INSTRUCTIONAL MEDIA

Technology assets are strongly tied to the likelihood that people engage in personal learning online (Horrigan, 2016a). Higher education courses, whether face-to-face or online, require that students use these assets to access information for learning success. Greater digital readiness generally translates to higher level of use of technology in learning (Horrigan, 2016b). It isn't the digital readiness alone that facilitate higher learning gains for students. From the instructor side organization and design quality of the media being accessed by or presented to students is instrumental as well. Students transitioning to college may be avid users of digital technologies, but may have a lower media literacy quotient as it pertains to using these devices effectively in the information rich environment of college. The course related information access demands in higher education vary substantially from the PreK-12 experience. Today's teenagers bring to school a rich and different set of literacy practices and background that is often unacknowledged or underused by educators (Considine, Horton, & Moorman, 2009). Adding to the media divergence between higher-education faculty and students is the probability that any given faculty member is designing instructional media for a scholarly audience one would find at a professional conference. It is the responsibility of today's educators to build a bridge between the knowledge students already have and the content that they need to learn to be successful inside and outside of school (Considine, Horton, & Moorman, 2009). Similarly, it is important to account for the multimedia conditioning the millennial students arriving at college have experienced by designing media that aligns with their experience.

While almost all online adults age 18-29 (95%) and most of those age 30-49 (87%) watch and/or download online videos, that figure drops to 58% among online adults age 50 and older (Purcell, 2013). Younger viewers are more often drawn to entertainment related video content, whereas older viewers gravitate toward educational videos. In the reading realm younger viewers are more likely to read for the purpose of researching a specific topic of interest than for work or school (Perrin, 2016). Students entering college are faced with substantial contrast between engaging the self with videos and readings of personal interest, and an overload of textbooks, typed instructor narratives, course management site data dumps with numerous linked media-intensive sites, text-intensive PowerPoint notes, threaded dialog, instructor generated and third-party videos, email, audio-narrated screen casts, and live-lectures.

Amidst the array of media supporting the pontification of conceptual knowledge from course to student, textbooks are a common foundation underpinning the process. The 15+/- chapter organization closely aligns with the semester model. A growing share of Americans are reading e-books, but print books remain much more popular than books in digital formats (Perrin, 2016). The main advantages and selling points for the use of e-books from the student standpoint is their rapid attainability, portability, interactivity, linked media, and various internal features such as the ability to highlight text and search for information. The instructor realizes the same advantages, but with the allure of being able to update content more efficiently. In addition to the informational textbook/e-textbook component that is potentially underpinning the course, an instructor oftentimes has access to a number of other instructional technology tools: (a) Course management system (CMS) to house digital resources; (b) Presentation delivery tools such as PowerPoint; (c) Multimedia projectors to allow the visual representation of numerous ideas limited only by the instructors' imagination; (d) Clickers to provide students with real-time interaction during a lecture; (e) Lecture capture systems such as Panopto; (f) Screen capture and Podcasting software for instructor media design; (g) Audio projection systems; (h) The Internet tapped in to unlimited information; and (i) Streaming media sites (YouTube, Infobase Films on Demand, iTunesU, etc.). Given the number of engagement tools and content-supportive media at an instructor's fingertips it is important to design media to meet the needs of our millennial students.

4. INSTRUCTIONAL MEDIA SHORTFALLS

The instructional tools are many, but our text-dependent tendencies may be limiting our progress with the tools to meet the digital natives' visual-media learning evolution. Long ago Thomas Edison purported that motion pictures will revolutionize our education system, potentially replacing textbooks (Wise, 1937). As an educational system we've integrated the use of video substantially, but it still stands as a linked media used to support print-based information. The e-textbooks have transitioned to i-textbooks to allow user interactivity (playing videos in-line with the text and performing instant searches on text), but the text is still the overarching medium with other media tacked-on to support it. In fact, this hyperlinking, or more appropriately termed "excessive" linking, has resulted in the emergence of another increasing issue, cognitive overload. As Clark and Mayer (2016) indicate, the act of doing (physical activity) can impede the process of learning (psychological activity). The high number of linked choices in any instructional set (textbook chapter, weekly CMS module, etc.) inevitably goes uncalculated with regards to the time needed by a student to follow and engage the media, and the screen space limitations of Millennials'' mobile computing tendencies. One of the most important instructional benefits provided by the portability of cell phones is their support of anywhere/anytime access to course material (Thomas & McGee, 2012). If the course materials are too complex they do not lend benefit to the mobile interface. From the optimum multimedia design principle standpoint there are a number of additional design guidelines noted by Clark and Mayer (2016) that the author of this paper noted are being overlooked in higher-education media design as well. In addition to the design principles and in light of Millennials' visual media upbringing, the vast reliance upon text-based proliferation of course content needs rethinking. Let's take a look at the contrast between the Millennials' mainstream media disposition, and the professorial instructional media to see where the disconnect lies.

One of the important, often difficult tasks of a professor is to take an enormous amount of information on a given subject and pare it down into a series of learning events manageable by a broad array of students within the allotted quarter or semester time limit. Often the course catalogs provide general guidelines for workload, such as 45 hours of work per unit in a three-unit course. As the professional who has been enthusiastically studying the course content for years it is difficult to realize how long it takes a novice student to process and internalize a given module of information. It is reminiscent of the digital native and digital immigrant relationship where one is like a native speaker, and the other frequently misconstrues meaning. Prior to the Internet, CMS, and e-books, inline instruction comprised of lecture, non-linked textbook, and lecture notes was the mainstay of course design. This was sometimes accompanied by supplementary on-reserve library articles. After the Internet infiltrated higher education textbooks morphed into a compendium of the usual content along with numerous links to videos, websites, and volumes of other supplemental information. Rather than dial-down the content we want our students to learn, we've inflated it substantially. In addition, the presentation of the material has remained in a text-based medium rather than keep pace with the increasing visual media consumption among student generations, currently Millennials.

The e-textbook was conceptualized and made available to meet both, the spiraling costs and the increasing mobile-technology use. For the Millennial learner mobile has manifested primarily with Smartphones rather than tablets, which poses screen space limitation issues. At least one feature listed as a benefit of the e-textbook, linked media, can also be a negative point. Often there are too many linked choices and too much irrelevant information which wasn't vetted adequately for optimum benefit to the millennial learner. In order to derive the full benefits of mobile computing, the implementation efforts should be accompanied by the necessary technological infrastructure (Shim & Shim, 2001). Analysis of one similar chapter, Motivation, among three popular Educational Psychology e-textbooks (Table 1) reveals a common trend among higher education textbooks: The minimal use of non-text, content-supportive visual images.

Table 1. Textbook supplemental media occurrences within one chapter pertaining to the topic of Motivation in Educational Psychology

	Textbook Author		
	Woolfolk	Slavin	Ormrod
Supportive Images	1	2	8
Non-Supportive Images	1	0	9
Keyword Definition Links*	47	16	43
Video Examples*	8	5	10
Web-content Link*	7	9	6
Text-based Figures	7	3	14
Self-Checks*	6	1	7
Audio Podcasts*	1	0	0
Pages in Chapter	44	24	52

Note. *Items had hyperlinks that opened a new browser tab or popup window.

Although the specifics of presentations in any given lecture will vary by discipline and subject-matter, the supportive PowerPoint presentations that textbook publishers provide for instructors (Table 2 & Figure 1) are representative of the visual support commonplace in many lectures. It is one reason why PPT has been negatively termed, *PowerPointlessness*. When considering the use of text in a presentation it is important to realize that you (the speaker) are the text. The visual image is the meaning. Aside from key words that could be misheard, subtitles for second language listeners, and youth learning to read, the use of text and narrative voice together breaks a fundamental principle of multimedia design. The *Modality Principle*, presenting words in audio rather than on-screen text, prompts significant learning gains (Clark & Mayer, 2016).

Table 2. Educational Psychology textbook supplemental PowerPoint pertaining to the topic/chapter on Motivation

	Textbook Author		
	Woolfolk	Slavin	Ormrod
Supportive Images*	1	1	2
Non-Supportive Images	1	1	1
Video Examples	0	0	0
Text-based Figures	0	0	4
Text-dominant Slides	31	18	22
Slides in Chapter Presentation	32	19	24

Note. Supportive images helped communicate information effectively.

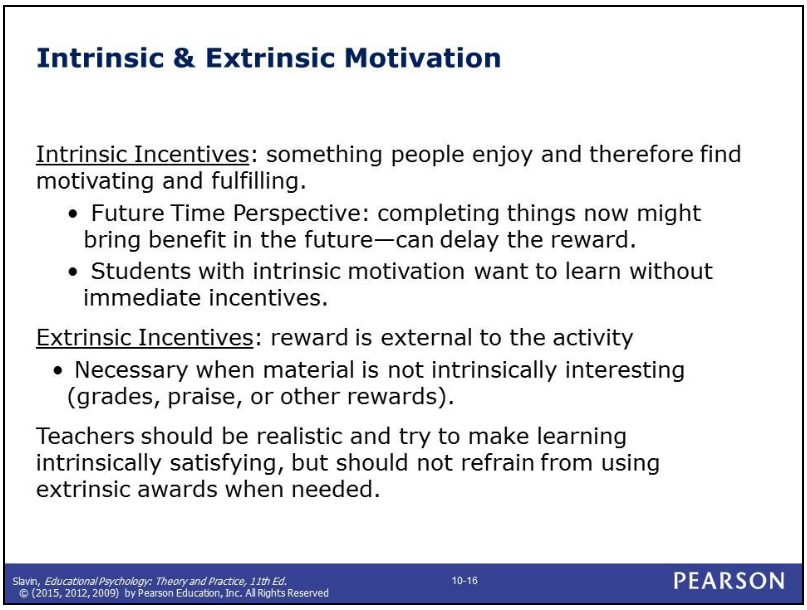

Figure 1. Example of text-dominant slides, the most common visual in the supplemental textbook chapter PPTs

Designing and developing motion video, interactive infographics, or illustrative animations is a time-intensive, costly endeavor. Simply locating and legally accessing high definition static images that can help communicate meaning as you present is also costly and time consuming. YouTube and other media streaming sites have helped bring some noteworthy visual support to the teaching and learning process. There is still a tendency to lean on talking-head or text-invasive motion videos. This can be due to the afore mentioned constraints, and to the disconnect between prescribed multimedia design principles and the producers of media. The most successful instructional uses of video tend to come from the high-end commercially produced compilations, or the use of video vignettes as case studies to help students apply learning concepts. More often in higher education, however, the use of motion video results in Modality Principle issues (Figure 2), or in a talking head without visuals to support the points being discussed.

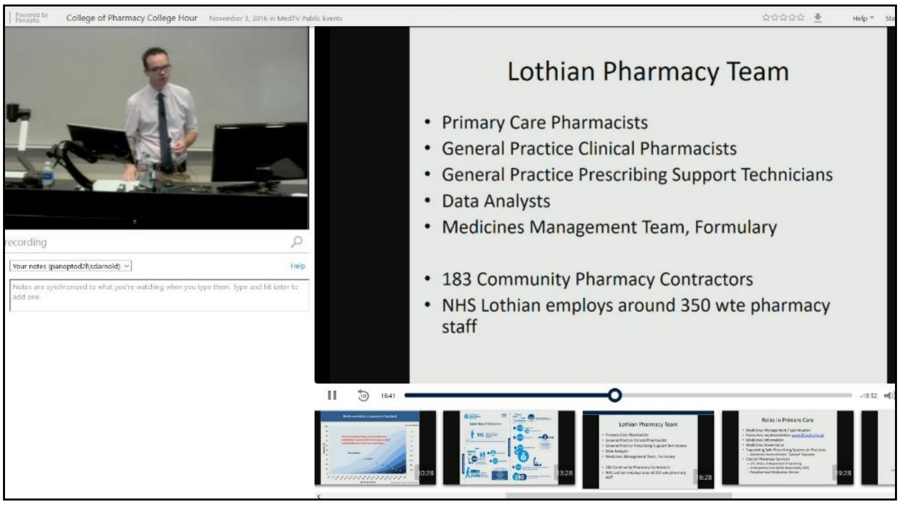

Figure 2. Panopto lecture capture breaking the "Modality Principle"

5. CONCLUSION

Whether students or professional, usability of a device is important in regards to educational content quality and excellence of service to users (Shin, Shin, Choo, & Beom, 2011). The Millennial students' reliance upon smaller mobile devices, and their visual media preferences warrant a rethink on how we are designing media for their benefit in higher education. Media that meets the digital natives' preferences will resonate with the media design principles and offer a visually stimulating experience for the nontraditional students as well.

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TELLING THE STORY OF MINDRISING: MINECRAFT, MINDFULNESS AND MEANINGFUL LEARNING

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ABSTRACT

This paper describes a unique project known as MindRising Games. It reports how the innovative use of Minecraft™ combined with the principles of mindfulness and meaningful learning contributed to rich digital story telling. MindRising Games was a competition, which was part of the 100-year commemoration of the Easter Rising, designed to celebrate 200 years of the Island of Ireland. It involved over 450 young people and educators from nearly every corner of Ireland in a digital exploration of the past, the present and the future. In brief, MindRising Games was about telling digital stories through the experiences of today's youth in reflecting on the events of 1916 and reimaging what the next 100 years could bring for Ireland. Participants were required to create a project portfolio in Sway, build a virtual world in Minecraft™ and make a short video showcasing their efforts. These videos provide a rich archive and valuable insight in to the level of mindfulness and meaningful learning generated by the MindRising Games projects.

KEYWORDS

Minecraft™, MindRising, Mindfulness, Meaningful Learning, Ireland

1. INTRODUCTION

There is renewed interest in the educational potential of computer games (Kangas, Koskinen & Krokfors, 2016). The power of play is now a serious field of academic research, as evidenced by the number of books and journal articles published on the topic (see for example, Whitton, 2014). Notably, even before the latest Pokémon craze the popularity of the computer and video gaming industry is reported to surpass worldwide revenues generated by Hollywood movies (Barab & Jackson, 2015). Despite popular stereotypes that male teenagers dominate gaming, the average computer and video game player is estimated to be 35 years old, with women over the age of 18 (33%) representing a significantly greater proportion of the playing population than boys age 18 or younger (15%) (Entertainment Software Association, 2015). While the educational potential of computer games is widely acknowledged in the literature the challenge for educators is to go beyond "play" by finding ways of integrating such experiences in meaningful learning activities, which provide transformative advantages over conventional teaching methods. This point is reiterated in a systematic review and meta-analysis of the literature, which identifies 'the importance of questions that ask not if but how games can support learning' (Clark, Tanner-Smith & Killingsworth, 2014, p. 14).

This paper describes an innovative project that sought to better understand how to harness the educational potential of one of the world's most popular computer games—namely, Minecraft™ (Butler, Brown & Mac Críosta, 2016; Mac Críosta, Butler, & Brown, 2016). It reports on the MindRising Games initiative first launched in February 2016. This was a unique competition for young people (aged 6 to 14 years), which was part of the official commemoration activities for the 100-year anniversary of the Easter Rising. In Ireland, the 1916 Easter Rising also known as the Easter Rebellion was an armed insurrection over the Easter period in Dublin against British rule. The MindRising Games project involved an exploration of the past, the present and the future through digital story telling mediated through Minecraft™ to reflect on, and project forward, to 200 years of the Island of Ireland. In this paper we briefly outline the rationale for selecting Minecraft™ for this initiative and the basic design of the MindRising Games competition. We also outline some of assumptions and guiding principles about mindfulness and meaningful learning which underpin the project.

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After describing the official launch the paper explains the development process that almost 450 young people engaged in leading up to the final MindRising Games celebration event in May 2016. Drawing on the experience of this event we reflect on the success of MindRising Games and discuss future initiatives that might help to bring ‘Blockheads’ and ‘Grayheads’ together to tell digital stories about Ireland.

2. WHY MINECRAFT?

Immersive virtual worlds are capable of facilitating highly interactive, engaging, collaborative and multimodal learning experiences (Lee, Dalgarno, Gregory & Tynan, 2016). While they have great potential and have generated considerable interest leading to increasing uptake by educators over recent years, platforms such as Second Life, Active Worlds and Open Simulator have yet to become widespread or mainstream in educational settings, evidenced by few large-scale implementation projects. A recent literature review on the use of Minecraft™ offers a useful discussion of the benefits and limitations of this popular computer game for educational purposes (Nebel, Schneider & Rey, 2016). Minecraft™ is a game that allows you to explore virtual worlds and use blocks to build amazing environments from the simplest of homes to the grandest of castles. In contrast to some of the abovementioned virtual worlds, Minecraft™ has a growing following and has established itself as one of the world’s most popular computer games. Notably, almost 20,000 million copies have been sold for PC, 12 million copies for XBOX360, and more than 21 million copies for mobile phones, which places Minecraft™ on the all-time best-sellers list (Nebel, Schneider & Rey, 2016). It follows that Minecraft™ was ideally suited to an Easter Rising commemoration project, with the aim bringing both young and old people together to reflect on and tell digital stories about the past, present and future of Ireland. The game environment is relatively accessible, user generated, with flexible rules and modifiable components. Players can use the platform to build, explore and socialize with other users. It is noteworthy that the Minecraft™ community includes children, young people and adults, including silver surfers. Given the diverse player base and level of interest across generations in the Easter Rising, the MindRising Games project hoped to provide a unique digital experience that would bring ‘Blockheads’ and ‘Grayheads’ together.

3. LEARNING THROUGH MINECRAFT

From an educational perspective the use of Minecraft™ supports planning and self-regulation skills (i.e., mindfulness). The ability to build and re-create virtual worlds also lends Minecraft™ to a wide range of applications, including the accurate reproduction of existing environments and re-imagination of future places and spaces, which supports the integration of the game within the curriculum for authentic and meaningful learning experiences. This point helps to addresses the concern in the literature that a lot of learning, self-regulation and strategy development required in rule-based games does not readily transfer to real-world problem-solving contexts (Bransford, Brown & Cocking, 2000). Accordingly, the Institute of Education in Dublin City University (DCU), the largest teacher education provider in Ireland, was very supportive of the MindRising Games initiative. Moreover, the National Institute for Digital Learning (NIDL) hosted by DCU was a willing supporter along with Microsoft as the MindRising Games initiative was seen as an innovative vehicle for embedding the use of digital technologies in teaching and learning as advocated by the recently launched *Digital Strategy for Schools (2015-2020)* (Department of Education and Skills, 2015). This new Strategy, coupled with a *Roadmap for Enhancement in a Digital World (2015-2017)* for higher education (National Forum for the Enhancement of Teaching and Learning, 2015), recognises the importance of meaningfully integrating technology within educational contexts. In short, the MindRising Games project was seen as an innovative way of helping students develop a range of key 21st Century skills to fully participate and flourish in today’s globally connected world. These skills include the ability to reflect mindfully, communicate skilfully, collaborate effectively, problem-solve, innovate and construct new knowledge over the course of their lifetime. In this respect the basic premise was that learning through Minecraft™ in the course of this project was potentially a valuable way of bridging the divide between the traditional classroom and the new digital world outside of school to help better prepare young people for their futures.

4. LAUNCHING THE PROJECT

On February 3rd 2016, 120 people attended the official launch of the MindRising Games project at DCU. The launch was opened by Professor Brian MacCraith, DCU's President, and was designed to be highly interactive with all attendees participating in, and contributing to, stories from the past (and future) in order to seed potential MindRising Games projects. Notably, during the launch 25 primary school students from five different schools participated in a challenge to recreate from inside MineCraft the Morse code message sent from the General Post Office (GPO) in the week of the Rising. Prior to the launch the MindRising Games team created the General Post Office (Figure 1) and Dublin Castle in Minecraft™ to help illustrate the potential to teachers and scaffold participants in building their own virtual worlds. In this regard the MindRising Games competition sought to reimagine the teaching of history in school using digital storytelling techniques. Importantly, the MindRising Games initiative was part of the *Youth and Imagination* strand of the official Ireland 2016 Commemoration Program and was open to schools and groups on the island of Ireland and abroad. As part of the initiative a number of high profile MindRising Ambassadors were appointed, including Lord David Puttnan, Ireland's Digital Champion and multiple Academy awardee.

Figure 1. Minecraft rendering of General Post Office

5. DEVELOPING THE PROJECTS

After the closing date for entrants—schools, groups and individuals— at the end of February the intention was that participants would work together from March until the end of April 2016 on developing their digital stories across a range of media, including building elements of their projects in Minecraft™. More specifically they were encouraged to develop their own virtual world(s) to remember the past 100 years and reimagine what the next 100 years could bring for Ireland. Projects could consist of a variety of elements with video, audio and Minecraft™ animation. To scaffold this stage of the project educators and mentors were encouraged to attend a Minecraft 'bootcamp' and ongoing support with design thinking tools and tutorials were available on the MindRising Games website. A number of other historical locations were created in Minecraft™ including sites from Northern Ireland and a futurescape of urban living in a 2066 city featuring landmarks from Belfast, Cork, Dublin, Galway and Limerick (see Figure 2).

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Figure 2. Example of historical locations created in Minecraft

Sample lesson plans were also developed to support teachers. All content was freely available to download use and ‘hack’. In summary, in the development phase of the MindRising Games initiative participants were expected to create a project portfolio built in Sway, develop a virtual world in Minecraft™ and bring everything together in a three- minute video summarising their project. In other words, entrants were encouraged to document, publish and share their work through a range of media, including video snippets, audio recordings, Minecraft™ builds, ebooks, pictures, photos, Sway scrapbooks and so on.

6. CELEBRATING THE PROJECTS

All participants were invited to a one-day MindRising Games celebration as part of the Coolest Projects event in May 2016) to share and learn from each other. This event also gave an opportunity to recognise some of the most outstanding projects, with several awards for excellence across a range of categories. While not all of the entrants got to the finish line those who did produced some truly inspirational stories supported by impressive Minecraft™ environments, as illustrated below in the burning of the Cork City Hall in 1920. In addition to the virtual worlds the brief videos provide a rich archive of some of the successes and challenges faced in developing a MindRising Games project and many of these appear on the project website [www.mindrising.ie]. MindRisng16 attracted considerable media attention, with 11 stories published in newspapers, including the *Irish Times* and *Irish Independent*. A press release related to the awards ceremony describes the winning entries [http://www.dcu.ie/institute_of_education/news/2016/jun/mindrising-awards-ceremony.shtml]. In many respects this level of media interest is further evidence of how MindRising Games was successful in linkng to ‘Blockheads’ and ‘Grayheads’.

7. CONCLUSION

The focus now shifts to the future and the next MindRising Games proposed to start in September 2016. As Ireland moves into the second half of the 2016 commemorations there is a deliberate effort to look ahead to the future. Therefore, a meeting of many business, education and community leaders took place in July at DCU to reflect on the first iteration of the MindRising Games experience, and to discuss how Minecraft™

could become a valuable part of a number of future-focused projects already or about to get underway, including the Smart Cities, Smart Health and Smart Stadium initiatives. Cognizant of these projects the MindRising team are building this in to our plans and have exciting ideas for future competitions, including building a program focused on re-imagining our future through a hybrid of physical and digital worlds (e.g., connecting the real-world via sensors, cameras and data to the Minecraft™ worlds). Such a project would aim to seamlessly link smart physical cities with smart digital cities. Finally, the MindRising Games initiative was only made possible through a unique collaboration between Business Model Adventures, Microsoft, DCU's Institute of Education, and the National Institute of Digital Learning. This collaboration has helped launch the first in what all parties anticipate will be an annual competition, which could in the future expand to other countries. As Pokémon has taught us this year the computer and video gaming world can expand rapidly and is not restricted by national boundaries.

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GREEN IT MODEL FOR IT DEPARTMENTS IN GULF COOPERATION COUNCIL (GCC) ORGANISATIONS

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ABSTRACT

Environmental problems such as climate change, pollution, non-sustainable energy, resource depletion, and recycling Information Technology (IT) devices considered the biggest glitches which are facing developed and developing countries. IT devices have become a critical issue due to the great amount of environmental damage caused by IT companies from consumption of resources, raw materials, energy, and waste disposal. To tackle this problem, sustainability strategies have become crucial in Information Technology (IT) organizations - private and public. Sustainability and Green Information Technology (Green IT) have been introduced to reduce these environmental issues and increase the sectors' needs in a direction away from older IT. Green IT and sustainability aspects are essential to reduce the environmental damages that run rampant in developed countries such as Australia, USA, and the UK. However, in developing countries such as Gulf Cooperation Council (GCC) countries, China, and India, there are difficulties in applying Green IT models since they were introduced to meet the developed countries' needs especially in GCC. Currently, the organisations in GCC countries do not consider sustainability in their strategy to reduce the environmental impacts; however, GCC countries are causing a great deal of environmental damage due to their economic growth in different sectors such as oil, gas, and telecommunications. Furthermore, GCC countries are sharing the same policies to achieve the financial stability and change in the oil market. Thus, this research aims to develop a Green IT model for GCC in IT departments to reduce the environmental impacts. A mixed-methods approach will be employed to assess the GCC's needs and to examine the new model.

KEYWORDS

Sustainability, Green IT, Model, GCC, IT department

1. INTRODUCTION

Green Information Technology (Green IT) is an essential term for organizations that wish to reduce their Information Technology environmental impacts. Currently, computer manufacturing consumes a great amount of raw materials, water, electricity and chemicals that generate hazardous waste (Murugesan & Gangadharan 2012). However, "Green IT benefits the environment by improving energy efficiency, lowering greenhouse gas emissions, using less harmful materials, and encouraging reuse and recycling" (Murugesan and Gangadharan 2012, 2). GCC is a group of countries comprising six Arabic countries: Saudi Arabia, the United Arab Emirates (UAE), Qatar, Oman, Bahrain, and Kuwait. "These countries own approximately 45% of the world's crude oil reserves and around 15% of the natural gas reserves" (Al-Kuwari 2009, 39). GCC countries are following a new domestic investments policy that focuses on petrochemical industries to minimize the investment in the oil (Sassanpour & Dept 1996). A recent research by KPMG International, comparing the "75 largest listed companies in Europe, the Americas and the GCC region, shows that only 11 percent of GCC companies have a stated sustainability strategy, policy or vision, compared with 85 percent in the Americas region and 95 percent in Europe" (Cooperative et al. 2012, 18). "The GCC region has the highest energy consumption in the world, and this trend is not expected to change as GCC countries increasingly rely on energy-intensive desalination plants"(Meltzer et al. 2014). In order to develop a Green IT model, the researcher has to investigate the GCC countries' needs and necessitates in terms of Green IT and sustainability. In this proposal, the researcher will critically discuss the brief historical background of Green IT and sustainability; and will demonstrate its benefits for business and how highly- rated companies save cost and reduce environment impacts by implementing a Green IT model. Also, the researcher will employ a mixed-methods research approach - qualitative and quantitative - to collect the data from GCC.

Currently, researchers in different parts of the world have been exploring the success of the development of the Green IT from large-scale firms, E-learning, E-government, and other variables that determine the effectiveness of Green IT (Coomonte et al. 2013; Cho et al. 2012). In addition, the changing nature of technological advancement requires scholars to investigate the recent challenges to IT greening process development on the basis of up-to-date information. Green IT tools are used to reduce the consumption of environmental resources and sustain the business process. For example, cloud computing can reduce the consumption of great amounts of hardware, electricity and hard paper. Also, using cloud storage tools will offer the wider availability of user's documents and reduce the use of USB flash drives. "Virtualization and cloud computing to increase the utilization ratio of already installed servers from 10% to more than 50%" (Mueen Uddin 2012). Computer Virtualization is another good computing service that helps organisations to become greener, which allows users to use a computer's services virtually, meaning that one physical server that runs in the datacentre will operate all users' virtual computers. "Virtualization enables data centers to consolidate their physical server infrastructure by hosting multiple virtual servers on a smaller number of more powerful servers, using less electricity and simplifying the datacentre" (Murugesan & Gangadharan 2012, 29). This paper aims to develop a Green IT model for IT department in GCC countries to reduce the environmental impacts.

2. RESEARCH LITERATURE REVIEW

2.1 Governance

"Green IT governance helps companies structure their Green IT responsibilities" (Schmidt & Kolbe 2011). There were different Green IT model that takes on account governance to have a successful implementation government organise the responsibilities and gives the authority to the implementers. For instance, Green IT Readiness (G-readiness) is a Green IT model adopted by Molla et al (2009) , G-readiness model has been divided into five main sections: Green IT Attitude, Policy, Practice, Technology and Governance. "G-readiness is an organization's capability as demonstrated through the combination of attitude, policy, practice, technology and governance in applying environmental criteria to its IT technical infrastructure" (Molla et al. 2009). Furthermore, "Contingency Model" is a Green IT model developed by Schmidt & Kolbe (2011), which focuses on governance. The model gives clear design instructions on how to legalize a new Green IT approach to force a company's shift to greener practices. "The flexible Green IT governance model presented allows a company-specific design of Green IT governance" (Schmidt & Kolbe 2011, 5). "Businesses face higher energy costs, and they may also incur additional government levies if they don't address the environmental implications of their practices" (Murugesan & Gangadharan 2012, 26).

2.2 Information Technology

In general, sustainability is the ability make something sustain itself or to be maintained. "A sustainable policy, in general, is one that we can continue to follow in the long run" (Bonevac 2010, 85). Historically, in 1987, sustainability as a term became familiar in order to achieve public policies; however, sustainability as a term has become more diverse and become involved in different areas (Kuhlman & Farrington 2010). One of the most popular common definitions for sustainability is the Brundtland definition: "Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987, 16). Extrapolating from all definitions, it is the sustainable ability to use something continuously without harming the environment. Sustainability as a term became more popular during the environmental movement and was applied throughout the 1990s, that made business processes or practices more environmentally friendly; many industries including manufacturing, auto, steel, cement, and electric power began to bring environmental considerations into the decision-making process from early concept designs to final production (Starik & Marcus 2000). At the beginning of 2000 the "green" term start to appear in media worldwide linked to environmental business practices. Then, the green business shifted from an unknown practice to a significant activity for organizations. However, some of green business adopters realized other benefits of adopting green methodology in earlier stages. Thus, some of these new

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green business are referred to as window dressing or green washing (Ganesh 2007). According to Boudreau et al (2008), Green IT and Green Information System (IS) are the main factors for supporting sustainable economies worldwide and Green IT and IS are nowadays involved in many business processes . Thus, giving attention to the IT sector will lead to increase eco-efficiency, and to reduce the energy consumption, as this is the main issue in most IT departments. Green IT mainly focuses on energy efficiency and equipment utilization; Green IS focuses on the information management and design that help to improve the greening process (Boudreau et al. 2008). The importance of Green IT first rose in early 2000, synchronously with the new technology revelation. The new technology has made mass damages on environmental resources, due high demand of new technology worldwide. People and experts from different technology area have started to spread the disadvantages of using new technology through the media. However, attention is never given on how to minimize the damage. A BBC environmental report found that "manufacturing a 24 kg PC with a monitor needs at least 240 kg of fossil fuels to provide the energy and 22 kg of chemicals. Add to that, 1.5 tons of water, and your desktop system has used up the weight of a sports utility vehicle in materials before it even leaves the factory" (Hirsch 2004, 1). These issues create opportunities for IT and business researchers to start to build new business models that reduce environmental damages and improve productivity.

2.3 Social and Cultural

“The level of commitment to sustainability communicated in both a firm’s CSR reports and its social media outlets may yield important insights into the values underlying a firm’s culture” (Reilly & Weirup 2011, 4). Social media is considered as one of the very powerful tools that have helped people to become greener, lately. Social media has different advantages, such as allowing people to share information and ideas using a computer network. For instance, making a virtual meeting using social media will prevent people having to travel, reducing travel expenses and environmental resources. “Many corporations have become active users of social media in communicating their sustainability change initiatives” (Reilly & Weirup 2011, 3). In addition, lately social media creates new business environments for users, which reduce high expenses for small businesses. “Developing countries are highly concerned by e-waste problem and that Green-IT offers opportunities and allows for economic, social and environmental benefits” (Hanne 2011, 426).

2.4 Green Management

Green IT is not limited to technological innovations such as energy-efficiency, green data centers, cloud computing, and server virtualization. Green IT also included within new organizational strategies and practices such as management and e-waste (Harmon & Auseklis 2009). For example, Green IT organizations have a waste management program that take dumped IT equipment to be reused by other IT departments or sent to recycle management. As part of green management Adobe came up with a green solution to working with IBM to move from traditional physical servers to being fully virtualized and having cloud computing (IBM Green Report 2012). Adobe removed more than 120 physical servers from their data centre by using five virtual, powerful IBM servers instead. This green strategy will make them reduce environmental damages and save more than $60 million in five years due to reductions in the cost of energy bills, server maintenance, and software license fees. Thus, management is essential to apply after implementing a green model, since they offer high business productivity and reduce environmental damage. Some organizations have successfully implemented Green IT solutions in their business processes.

3. RESEARCH METHOD AND RESEARCH QUESTION

Environmental damage is a worldwide problem that just keeps getting worse and needs to be addressed immediately. This research will provide a thorough investigation of different Green IT model and will conclude with a Green IT model that suits GCC. This study aims to address and answer the following question, How can a Green IT Model meet the GCC Countries requirements. Both qualitative and quantitative research with multiple levels of employees to obtain data pertaining to their opinions, routines, areas of improvement, and willingness to learn the new system. The entire process will take up to three years, but will forge a path for future resources savings and excellence of service.

4. THE RESEARCH OUTCOMES

Thus, the outcome of this research is a Green IT model for GCC countries to reduce the environmental impacts produced by IT departments. The researcher proposed a framework based on the current literature review namely: governance, social and cultural, Information Technology and green management. To achieve the objective of this research, the researcher will expect factors to be unclear until the information is examined more closely. For instance, this research expects that the IT department in a telecom company uses very advanced technology compared with midsize business IT departments. In this case, the factors will differ due to the business's needs. In addition, this research is unlimited to the current researcher's factors, which might be updated during the stage of data collection and investigation, which will thus help discover more contributing factors. This research will reveal policies for recycling and choosing suppliers. Involving customers in the IT strategy plan will contribute to taking the client's feedback, needs, and innovations into account. One of the research factors is developing a green policy for this particular business firm.

5. CONCLUSION

In conclusion, the primary outcome of this research will help organizations in GCC countries to become more sustainable. The research studied different Green IT models to find the gap between current models and GCC's needs. To make this research more accurate, the researcher will employee mixed method approaches namely: interview and online survey for IT department in GCC. The Green IT model will discuss an approach for Green IT called Social and Cultural. Moreover, the research will provide the management, decision makers, and strategic planners in business firms who will be undergoing these processes with the overall concepts. It can also allow the business firms to understand that the IT greening process is not necessarily a smooth process in all instances, thus giving rise to a proactive approach to the management, while still incorporating IT greening processes into the firm. The research will provide managers, as well as scholars, with up-to-date information about the issues related to developing a new Green IT model in a developing country, thus indicating that the research tends to make a valuable contribution.

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HOW DOES THE USE OF MOBILE DEVICES AFFECT TEACHERS' PERCEPTIONS ON MOBILE LEARNING?

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ABSTRACT

The purpose of this study is to investigate the potential impact and effectiveness of mobile learning in the context of a flipped classroom and also address implications for future curriculum design. The researchers developed a mathematics curriculum featuring the use of mobile devices in the context of a flipped classroom. Thirty pre-service secondary teachers participated in the study. They completed a pre-study survey, student reflections about the usefulness of mobile learning, and a post-study survey of their views on their use of mobile devices and their TACI classification scores. Results show there was a statistically significant difference in students' TACI scores between the pre-survey and post-survey. Mobile devices were mainly used for task performance in individual learning and group discussion in cooperative learning. Students' potential and self-confidence were improved through connection, communication and collaboration activities using mobile devices. For better pedagogical scaffoldings in classroom environments, four necessary conditions were suggested in this paper: approachable convenience (access route to a website), the convenience of using mobile devices (free data environment), promotion of real-time interaction between students (instantaneous messaging), and connection between communicating and sharing activities from group discussion to whole class discussion.

KEYWORDS

Flipped classroom, mobile learning, TACI, mobile connection, mobile communication, mobile collaboration

1. INTRODUCTION

Multinational and multischool cooperation can achieve education for promoting sustainable development in order to jointly respond to problems related to social changes due to technology. Communication and sharing in a community are basic principles of learning for sustainable development. In a rapidly changing technological era, knowing how to communicate and share through the use of mobile devices as learning tools is a valuable asset for future society (Deming, 2015). Mobile learning has enabled students to expect seamless connectivity whenever and wherever they are to interact with various information through innovative advances in information technologies. With mobile technology, students can save time, engage in convenient self-directed learning activities, and experience cooperative learning by communicating with their classmates. In addition, systematic connections between individual and cooperative learning in mobile learning environments help to flip a class. However, mobile learning cannot be successful without autonomous participation. The teacher's capability to promote students' participation is what will make or break mobile learning by combining individual and cooperative learning (Jensen et al., 2002). Because a flipped classroom cannot be successful without students' learning autonomy, teacher's capabilities to promote their autonomy are especially important in this type of learning environment. In order to develop these teacher capabilities, we can help teachers perceive the effectiveness of mobile learning by changing their perceptions of mobile devices in a positive way and then improving their perceptions of mobile learning activities with ideas about how to motivate students' participation and promote their autonomy in class. The purpose of this study is to develop a curriculum based on mobile learning in the context of the flipped classroom and to analyze how this curriculum affects pre-service teachers' perceptions of mobile devices and mobile learning activities. This study specifically is guided by the following two research questions: "How does mobile learning in the context of the flipped classroom affect pre-service teachers' perceptions of mobile devices and learning activities?" and "What are the necessary conditions to improve mobile learning environments in the context of the flipped classroom?"

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2. RESEARCH METHOD

Participants were 30 pre-service teachers taking a course in computer and mathematics education in a university in Seoul, South Korea during the spring 2015 semester. Four instruments were used to collect primary data: participants' perceptions of mobile devices and mobile learning activities and the necessary conditions to improve mobile learning environments. First, student adopter index classifications were measured using Technology Adopter Category Index (TACI) (Dugas, 2005). The second questionnaire asked how often students used mobile devices for different kinds of activities. The third questionnaire was used to gather students' perceptions of the usefulness of mobile learning. Based on the three themes of connectivity, communication, and collaboration, students were asked to reflect on how the use of mobile devices can improve their self-confidence and engagement in mobile learning. The last reflection questionnaire solicited students' thoughts on four categories of interaction with the mobile resources (i.e., how to use, connect, communicate, and collaborate) and their recommendations to improve mobile learning environments (Kim et al., 2013).

3. RESULTS

3.1 Perceptions of Mobile Devices

We used paired *t*-tests to assess the difference in means of TACI scores from the pre-questionnaire and post-questionnaire, and the result was statistically significant, as shown in Table 1. Specifically, more participants were classified with a lower TACI in the post-questionnaire than in the pre-questionnaire.

Table 1. The difference between the means of TACI from the pre- and post survey (Note: *p < .05)

TACI score	Pre-survey	Post-survey	df.	t	Sig.(2-tailed)
	M (SD)	M (SD)			
	5.43 (1.33)	4.63 (1.56)	29	2.89	0.007*

One interesting finding was that participants indicated that the usage of mobile devices engaged them more in viewing contents, collaborating activities, academic purposes, and professional development than before.

Table 2. Frequency summary of use of mobile devices (Note: *p < .05)

Contents	Pre-survey M (SD)	Post-survey M (SD)	df.	t	Sig. (2-tailed)
Reading contents (e.g., news, articles, etc.)	1.40 (0.89)	1.53 (0.57)	29	-0.75	0.459
Listening contents (e.g., news, podcasts, etc.)	1.07 (1.08)	1.40 (0.89)	29	-2.28	0.030*
Watching contents (e.g., TV, YouTube, etc.)	0.67 (1.06)	1.10 (0.80)	29	-2.04	0.051
Internet search (e.g., Google, Yahoo, etc.)	1.40 (0.62)	1.53 (0.73)	29	-0.72	0.475
Creating contents (e.g., news, articles, etc.)	-0.70 (1.05)	-0.90 (0.84)	29	1.24	0.227
Sharing contents (e.g., document, files, etc.)	-0.13 (1.20)	-0.23 (1.14)	29	0.41	0.682
Connecting activities (e.g., information access, social networking, etc.)	1.43 (0.82)	1.60 (0.56)	29	-1.00	0.326
Communicating activities (e.g., phone call, email, etc.)	1.30 (0.79)	1.37 (0.85)	29	-0.32	0.752
Collaborating activities (e.g., group work, discussions, etc.)	-0.17 (1.05)	0.47 (1.01)	29	-3.74	0.001*
Classroom activity (e.g., reading and watching contents, etc.)	0.23 (0.97)	0.53 (0.97)	29	-1.56	0.130
Academic purposes (e.g., group works, assignments, etc.)	-0.10 (0.99)	0.53 (0.97)	29	-2.92	0.007*
Social activities (e.g., Facebook, etc.)	1.37 (1.03)	1.30 (0.79)	29	0.42	0.677
Professional developments	-0.73 (0.94)	-0.10 (0.99)	29	-3.36	0.002*
Entertainments	0.07 (1.34)	-0.03 (1.33)	29	0.37	0.712

3.2 Perceptions of Mobile Learning Activities

To answer the second research question about participants' perceptions of mobile learning activities, we explored the characteristics of mobile learners in terms of their experience, as shown in Table 3. The results demonstrate that providing a mobile learning environment can help students be more confident in learning.

Table 3. Frequency summary of use of mobile devices (Note: *p < .05)

Contents	Pre-survey M (SD)	Post-survey M (SD)	df.	t	Sig. (2-tailed)
The use of mobile device is convenient and allows a flexible learning.	1.00 (0.83)	1.13 (0.63)	29	-0.75	0.459
The use of mobile devices enables students to take control of learning.	0.00 (0.96)	0.24 (1.02)	29	-0.94	0.354
It is good use of "dead time"	0.93 (0.94)	0.73 (0.83)	29	0.90	0.375
It fits for many different learning styles.	1.10 (0.66)	1.30 (0.60)	29	-1.29	0.206
It improves students' self-confidence in learning through mobile connection activities.	0.23 (0.82)	0.73 (0.83)	29	-3.18	0.003*
It improves students' self-confidence in learning through mobile communication activities.	-0.07 (0.74)	0.37 (0.89)	29	-2.44	0.021*
It improves students' self-confidence in learning through mobile collaboration .	0.07 (0.69)	0.53 (1.01)	29	-2.73	0.011*
It improves students' engagement in mobile connection activities.	0.63 (0.93)	0.70 (0.99)	29	-0.30	0.769
It improves students' engagement in mobile communication activities.	0.43 (0.86)	0.47 (0.97)	29	-0.18	0.856
It improves students' engagement in mobile collaboration.	0.50 (0.86)	0.50 (1.01)	29	0.00	1.000

3.3 Four Necessary Conditions

The analysis of the reflection question "What do you recommend to make the use of mobile device(s) easier for this project?" indicates that the majority of participants reported that the access route to a course website should be made more simple and convenient, with student comments such as: "The process of approaching to data (e.g., video clips and PDF files) should be simple. If there are many steps to watch a video clip, I may not often access to the data due to their inconvenience" and "Convenience of use (Blackboard app → Course selection → Message board →... Process is too complicated." Pre-service teachers seemed to think that content data used for individual learning and message boards for cooperative learning should be easily assessable in order to guarantee the effectiveness of learning. Thus the analysis of the first reflection question suggests the first necessary condition, *approachable convenience*, to improve mobile learning environments. The second reflection question is "What do you recommend to increase students' connection activities in using mobile devices for this project?" The majority of participants emphasized the environment of using free data in their responses. Statements from the participants that support this include "Mobile devices are convenient to watch a video clip, but their weakness is to be connected to Wi-Fi. Once I watched an internet lecture and could download its file, the price was reasonable" and "Watching video clips while moving back and forth is uncomfortable because students are using a small mobile data pricing. It would be better to upload files." In order to watch video clips for individual learning, the participants in the study felt that pricing issues for data use should be resolved. On the basis of the above evidence, we suggest the second necessary condition, *convenience of using mobile devices*, for improving mobile learning environments. The third reflection question is about how to improve communication, and the fourth reflection question is regarding how to improve collaboration in mobile learning environments and with mobile devices. In these two questions, the majority of participants reported that instantaneous messaging was needed as a communication tool to facilitate learning activities: "A message notice should pop up whenever someone uploads a message. Otherwise, it is not clear when to use" and "Instantaneous messaging helps to attract other's attention." It appears that the participants thought that if someone uploads his or her opinion on the website, an instantaneous messaging system can help them to effectively communicate and collaborate with their group members. Thus, *promotion of real-time interaction between students* is the third necessary condition for improving mobile learning environments. In order to upload a common group opinion on the course website, the participants in the study needed to communicate with their group members first. They communicated with their group members by using Kakao-Talk (free messaging and communicating software) and then summarized their communications to upload their group opinion on Blackboard. Even though they can hold a group discussion by using Blackboard, they used Kakao-Talk due to its instantaneous messaging system. Communicating activities among group members and sharing activities between groups had to be separated because participants had to use instantaneous messaging in communicating activities on Kakao-Talk and then upload a group opinion on Blackboard. *Connecting communicating activities with sharing activities* can improve the quality of communicating and sharing activities and their communicative convenience in mobile learning environments.

4. CONCLUSION AND DISCUSSION

In the context of the flipped classroom, we explored pre-service teachers' perceptions of mobile devices and mobile learning activities as well as necessary conditions for improving mobile learning environments through the use of mobile technologies. Based on the results of our study, we can conclude the following. First, mobile learning in the context of the flipped classroom affects pre-service teachers' perceptions of mobile devices positively. This result implies that mobile learning experiences may help pre-service teachers become more comfortable with using their own devices. If they change their beliefs about the use of mobile technology, they should be more likely to use mobile learning devices for pedagogical scaffoldings in their future classes. Second, our participants perceived the effectiveness of mobile learning activities in the context of the flipped classroom. A positive mobile learning environment can cultivate confidence in mobile technology use. Students' motivation and interests in mobile learning in the context of the flipped classroom initiate willingness to participate, and this willingness can foster self-confidence in learning (Keller, 1987; Wang & Lin, 2008). Finally, understanding the four necessary conditions for improving mobile learning environments in the context of a flipped classroom will help educators to design and implement appropriate mobile learning. The results suggested that accessing and viewing mobile contents should be simple and convenient for mobile connectivity, and mobile contents should be easily downloadable. It seems that these two necessary conditions can optimize the autonomy of individual learning in designing mobile learning environments. Furthermore, in order to maximize the effectiveness of cooperative learning, promoting real-time interaction between students and making a connection between communicating and sharing activities were suggested. Therefore, autonomy-optimized mobile learning in the effectively implemented context of the flipped classroom can dynamically combine individual and cooperative learning and then facilitate a synergistic effect on both.

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CATEGORIZING 'OTHERS': THE SEGMENTATION OF OTHER ACTORS FOR 'FAITH IN OTHERS' EFFICACY (FIO)'

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ABSTRACT

This conceptual paper provides an innovative categorization of 'others' for the variable of 'faith in others (FIO)'. Adopted by pro-environmental and sustainability literature, FIO refers to faith in the efficacy of other actors. Examination and integration of theories on sustainable pro-environmental behavior leads to the proposition, that 'others' can be segmented into two main categories. The two main categories are biospheric, and non-biospheric others, with non-biospheric others including the sub-categories of independent, and organizational others. How an individual perceives the efficacy of 'others', and the influence which these perceptions may have upon an individual's behavior, is also addressed. Thus, this paper contributes to a better understanding of the underlying influences of sustainable behavior, providing keys to improving business and policy strategies for sustainability and sustainable behavior.

KEYWORDS

Faith in others, sustainable pro-environmental behavior, biospheric others, non-biospheric others, independent others, organizational others

1. INTRODUCTION

Introduced in 1992 by Berger and Corbin, faith in others (FIO) is a variable which refers to faith in others' efficacy, that is, faith in the efficacy of other actors. FIO has since been increasingly adopted as a moderating variable for more specific pro-environmental behaviors, such as male eco-fashion, under the categories of green and pro-environmental behavior, and both of these categories can be recognized as being intricately involved in achieving global sustainability (D'Souza et al. 2015). Existing FIO literature currently describes 'others' as those who are not the self, and acknowledges only three categories of 'others'; governments, scientists and future generations. Hence, there is a dearth of development on the categorization and identification of 'others'. Such scarcity and lack of clarity in the categorization of 'others' creates limitations for research, as it would affect elements such as precision of research data and analysis. This paper focuses on achieving clarification of 'others' from the variable of FIO, by proposing a method of segmentation and developing categories for the segmentation of 'others'. Examples of how these new categories may be applied in the context of FIO is provided, however, the proposed categories hold the potential for more flexible and broader application.

2. CATEGORIZING 'OTHERS'

The original idea proposed by Berger and Corbin (1992, p. 81), was that "individuals could engage in actions that induce governments, scientists, or future generations to solve environmental problems…if he or she had faith or trust in the efficacy of these other actors." Appropriately, the study measured FIO through statements concerning participants' dispositions on the capability of science/scientists, technology, the next generation and legislators, to solve environmental problems (Berger & Corbin, 1992). In conclusion, the results supported the study's hypothesis that faith in the efficacy of others moderated both the degree and form of

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the relationship between environmental attitudes and support for the regulatory actions of others, whilst also stating, that the moderation was “apparent even though the FIO items do not refer explicitly to regulators.” (Berger & Corbin 1992, p. 86) Seven years later, the paper was used for a replicative study by Lee and Holden (1999), who provided selective quotes from the original work produced by Berger and Corbin (1992), as definitions for the replicated variables. Despite Berger and Corbin’s (1992, p. 87) inference that “more conceptual development is need on the “faith in others” moderator construct”, neither the work by Lee and Holden (1999), nor any other study, has attempted to develop the variable of FIO. At present, both works by Berger and Corbin (1992), and Lee and Holden (1999), remain the core references for FIO research; the definitional quotes included by Lee and Holden (1999) have been maintained as the definition and descriptions for FIO, and the examples of governments, scientists, or future generations as other actors also remain unchanged.

The construct of FIO is more complex than what has been presented, and one of the most important yet under-examined elements of FIO, is the identification of ‘others’. FIO is included in the range of research encompassed within the topic of sustainable behavior. However, despite sustainability being a societal concern, and the fact that all individual actions involve some form of interdependence, there are limited constructs and studies which address the efficacy of others’ influence, on individuals’ behaviors, and there continues to be no identification of ‘others’, which span beyond the three categories of future generations, scientists and governments (Berger & Corbin 1992; Rogers 2003; Rotter & Stein 1971). Based upon the generalization that ‘others’ refers to something different or external to oneself, this paper will continue with the inauguration that ‘others’ may be segmented into two main categories, being biospheric and non-biospheric others. The following will detail the segmentation categories, definitions of these categories, and also provide justification for the proposed segmentation of ‘others’.

2.1 Biospheric Others

As one of the two main categories of segmentation, ‘biospheric others’ comprises of nonhuman species as well as the biosphere itself, making it a category which is inclusive of the biosphere, plants and animals. More technically, the biosphere is a complex adaptive system, inclusive of the atmosphere, which contains mechanisms that “allow life to persist” (Levin 1998, p. 434). A common construct in pro-environmental literature is altruism, also known as pure, exocentric, or social altruism, which is defined as the direct focus and concern for others (Monroe 1996; Schwartz & Howard 1984; Snelgar 2006; Straughan & Roberts 1999). The term ‘biospheric-altruism’ was initially used by Stern, Dietz and Kalof (1993), developed from Schwartz’s idea that environmentalism can be treated as a type of altruism. A biospheric value orientation is the foundation for biospheric-altruism, and encompasses the existence of concern and “value orientation toward the welfare of *nonhuman* species or the biosphere itself” (Stern, Dietz & Kalof 1993, p. 325). Thus, creating the basis for the term and definition of biospheric others, which acknowledges the biosphere, plants and animals as ‘others’ which play a massive role in our lives.

Faith in biospheric others efficacy is in reference to believing in the efficacy or actions, of the biosphere, plants and all other nonhuman animal species. Keeping in mind that nature has a way of sustaining itself when left un-interfered, this natural cycle can be considered an ‘action’ of biospheric others. That is, faith in biospheric others includes to a degree, believing in the natural cycle of life and our biosphere, a belief in letting nature do its work, and minimizing interference of this natural cycle. It may also be perceived that faith in biospheric others’ efficacy is the belief that the biosphere, plants and animals, are capable of improvement, as well as the belief that biospheric others have the potential of achieving health and sustainability again. Hence, individuals may choose pro-environmental products or not to eat meat, if they believe in the capabilities of the natural cycle of the biosphere, plants and animals, and is therefore displaying faith in biospheric others.

2.2 Non-biospheric Others

The other main segmentation category of ‘non-biospheric others’, incorporates the homo sapiens species, a species more commonly referred to as humans, and is segmented into the sub-categories of independent, and organizational others. The sub-categories are defined below, followed by a discussion which justifies the segmentation.

2.2.1 Independent Others

Independent others refers to the specific individual/s with whom a person is holding the interpersonal communication with, inclusive of face to face, digital, and tele- communication. Independent others is applicable to specific friend and family members, but most importantly, it includes the specific individuals who are representing and communicating on behalf of an organization or company. The category of independent others acknowledges that despite working for an organization, each worker delivers an independent, and unique form of interaction with another individual. This interpersonal experience provides the basis for the assessment of that independent other's efficacy. That is, as someone interacts with a sales representative within a store, he or she will make an assessment of this sales representative (the independent other), which is based purely upon the interaction experienced with that sales representative (independent other). As a simple example, an individual would only have a regular gardener, if he or she believed in the capabilities of this gardener, and hence, is showing faith in independent others.

2.2.2 Organizational Others

The other sub-category of non-biospheric others is organizational others, which refers to organizations as a whole, encompassing its goals, as well as matters of quality and processes which span beyond an individual, or independent others' control. Similar to the definition of a business market in marketing theory, organizational others, would include companies or brands, institutional and government, as well as their claims on the quality of service, and mission statements (Pride et al. 2015). Assessment of faith and efficacy would be based upon an organization's official claims and goals. These claims and goals may be decided upon by one or more persons, and would also most likely involve, more than one group and supply chain, but are provided in representation of the organization as a whole (Pride et al. 2015). An individual seeking a specific brand of organic products, would be an example of an individual who has faith in organizational others, inclusive of that organization's claims on organic processes and quality of produce.

2.2.3 Justification of segmentation

The proposed method of segmentation of 'others' aims to cover all potential 'others' which one may encounter, and therefore, assimilates all actors who may have influence on an individual's decisions. Non-biospheric others has been divided into the sub-categories of independent and organizational others, in order to account for the possible incurrences of separate, yet concurrent evaluation of faith in independent, and organizational others' efficacy. The reason this scenario needs to be accounted for, is developed upon the basis that organizations are comprised of individuals. Although these individuals are working for and are representing, the larger organizations, their independent characteristics will be maintained, regardless of official organizational goals and images. Therefore, this specific individual will be given a unique assessment of efficacy, from those they interact with, as a personal impression of efficacy which is independent of that given to the organization for which they work for. That is, regardless of how poor an organization's image is, individuals can maintain a good personal image, from which faith in the efficacy of independent others may still be granted. The opposite may also be possible, where faith in the efficacy of the organization will remain strong, despite poor faith in the efficacy of one, if not multiple, independent others, within that organization. This leads us to an issue which is comparable to that found in co-branding, during which the brand image of one brand, may influence the brand image of the other brand involved in the co-branding (Pride et al. 2015). That is, it would be possible that an organization's image may influence an individual's image, and vice versa. Therefore, the level of faith in an organizational other may influence the level of faith in independent others, or the level of faith in an independent other may influence the level of faith in the organizational other, both of which may have an overall influence, on the individual's final behavior.

3. EXAMPLE TO ILLUSTRATE THE ROLE OF 'OTHERS'

This section provides an example of a sustainable behavior to illustrate the application of the categorization of 'others'. The sustainable behavior chosen for the example is solar energy adoption, which provides a context to how the categories of 'others' may be applied, and how different FIO may influence and affect the behavioral choices of an individual. The example is given in order to increase the understanding of the complexity behind sustainable behavior, and the importance of considering the influence of 'others' on individuals' sustainable behavior.

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3.1 Solar Energy Adoption

Details aside, solar energy and solar panels is a method of sustainability which involves individuals' existing environmental concerns, willingness to pay, strong interdependence, as well as complex information research and processing (Diaz-Rainey & Ashton 2008; Markard 1997; Roe et al. 2001; Sardianou & Genoudi 2013). The following provides a brief discussion which will refer to the basic scenario that an individual; goes online, finds a solar energy company, discovers the company goals and mission statement, calls for more information, and partakes in an exchange with one of the company's sales representatives.

If the individual had strong faith in biospheric others, they may or may not agree with the company's goals and mission statements. If they do agree, they may develop faith in the organizational other's efficacy, if they found the goals and mission statements too elaborate and unpractical, they have not have faith in the organization other, but may still call for more information, due to strong faith in biospheric others. As they call the organization to find out more, the sales representative assisting them fails to answer their questions, and does not sound at all interested in the conversation, resulting in a lack of faith in the independent other's efficacy. However, based upon the strong faith in biospheric others held by the individual, the positive general reviews on the company by previous customers (independent others) found online, and the overall mission statement of the organization (organizational others), despite this negative experience with the sales representative (independent other), the individual chooses to adopt solar energy with this organization.

This scenario may have resulted differently however, if the individual was very frustrated with the sales representative (independent other). The individual may choose instead, to give negative reviews of this company (organizational other), and stemming from their high level of faith in biospheric others, may seek another organization (organizational other) altogether for solar energy, as result of the poor experience with the independent other.

On the other hand, if the individual's faith in biospheric others was not as strong, and they were simply looking into the solar company due to a friend's recommendation (independent other), the company's goals and mission statements (organizational other) may not have had any influence at all, on their choice. However, if the sales representative was very helpful, resulting in strong faith in this independent other, the individual may also develop a sense of faith in the organizational other, and adopt the company's solar energy services. Either that, or despite a poor sales representative (independent other), weak faith in biospheric others, and no interest toward the company's goals (organizational other), due to strong faith in the friend who made the recommendation (independent other), that company's solar energy may still be adopted.

4. FURTHER RESEARCH

As seen in the example provided above, despite addressing just one sustainable behavior, the variety of outcomes depending on the types of others involved, and how others' actions influence the individual's final behavior, can be seen. The example also shows how individuals' final behaviors can be based upon the individual's degree of faith toward specific 'others'. We can also see that faith can be developed or lost, and how the assessment of one 'other' may influence the perception of faith in a different 'other'. Further research is in need to identify the degree and form of FIO, associated with more specific contexts, as well as the influence of these degrees and forms of FIO, on each other, and on an individual's behavior.

5. CONCLUSION

This paper focuses on providing a form of segmentation and categorization of other actors, stemming from the construct of FIO. Individual actions will always involve a form of biospheric and/or human interdependence, but the literature review on the development of FIO and 'others' shows there is a dearth of development in this area of sustainability. Hence, the analysis of existing theories and concepts within the literature has led to the proposition of a new method of segmentation of 'others'. It is proposed that 'others' can be segmented into two main categories, being biospheric or non-biospheric others. Biospheric others encompasses the biosphere and non-human species, inclusive of plants and animals. This category incorporates that belief the biosphere is capable of a natural cycle of life and sustainability, and that human interference should be minimal. Non-biospheric others covers the homo sapien (human) species, and is sub-categorized into independent others, and organizational others. Independent others relates to humans as individuals, whereas organizational others incorporates human representation as a group. This modern approach to the segmentation of 'others' acknowledges that individuals are interdependent on each other, as well as the biosphere, while also acknowledging humans as independent individuals, despite working for, or within, a larger group or organization. The example given in context to the sustainable behavior of solar energy adoption, shows application of the proposed segmentation categories of 'others', and brings into view, that how an individual perceives the capability of others' actions, can influence an individual's own behavior, and also, that further research applying more refined contexts is needed. This paper's conceptual development of 'others', contributes to a better understanding of others' influence on personal sustainable behavior. The categories proposed can be perceived as foundations for further development, as limitations of the paper include that the categories are only generally described, and lacks proof of usefulness in actual application. Further research may be directed at applying these categories to assist in the identification of specific types of others, their role, as well as the various degrees of influence these specific others may have, on certain types of sustainable behavior. In light of these new categories of segmentation, the potential of application and analysis contributes toward, but is not limited to, understanding of the intricacy and complexity surrounding the issues related to sustainable behavior.

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DESIGN THINKING: A METHODOLOGY TOWARDS SUSTAINABLE PROBLEM SOLVING IN HIGHER EDUCATION IN SOUTH AFRICA

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ABSTRACT

This short paper explores the potential contribution of design thinking methodology to the education and training system in South Africa. Design thinking is slowly gaining traction in South Africa. Design Thinking is gaining traction in South Africa. There is offered by the Hasso Plattner Institute of Design Thinking at the University of Cape Town geared towards empowering postgraduate students with extra skills set that are needed for sustainable development to be realised. This kind of training fulfills a need that has been discussed for years in South Africa. The need is for the higher education to empower graduates with knowledge and skills that will make a difference to society. South Africa has been continuously producing graduates that are unemployable and lack the ability to innovate and add value to society.

KEYWORDS

Design Thinking; Education for Sustainability

1. INTRODUCTION

Nelson Mandela said "education is the most powerful weapon which you can use to change the world. According to the United Nations education is one of the most powerful tools for sustainable development. Sustainable Development should meet current needs without compromising the future needs (Brundtlund, 1987). The Sustainable Development Goals seek to provide equal access to affordable universal access to a quality higher education were introduced in 2015. These are important in South Africa where education was used as a means of exclusion, separating races, class and cultures, while continuously producing experts in their fields. Furthermore, the access for many who were denied the opportunity in South Africa, the current higher education training has not equipped them with skills to innovate and create opportunities for employment. The skills deficiency has resulted in many graduates unable to secure income. Part of the challenge is the disciplinary silos in which they have been trained without the ability to collaborate. Education for sustainability requires that we rethink the training at institution of higher learning. Graduates need to be trained to deal with complex problems outside disciplinary boundaries (Rittel, 1962). Education for Sustainability is critical as government and industry seek sustainable development. Education needs to empower students with knowledge and skills to become critical thinkers that are capable to work collaboratively solving complex social challenges.

2. THE ROLE OF EDUCATION IN SUSTAINABLE DEVELOPMENT

Education for Sustainability (EfS) is defined as a transformative learning process that equips students, teachers, and school systems with the new knowledge and ways of thinking in order to achieve economic prosperity, and produce responsible citizenship while restoring the health of the living systems upon which our lives depend (Foster, 2001). Government, non-governmental organization and industry point to education as key policy instrument for bringing about a transition to sustainable development, but there is little being done to change the education (Huckle & Sterling, 1991).

Education is critical for promoting sustainable development and improving the capacity of people to address environment social and economic issues. Socially critical skills are essential for an understanding of the problematical concept of 'sustainability'. EfS seeks to develop the knowledge, skills, values and attitudes necessary to bring about the change which is also in line with design thinking which is also about changing the mindset. Furthermore, higher education should seek to produce individuals with critical skills to understand the complexity of environmental, social and economic problems and solutions and the ability to participate individually and collectively in the resolution of the problems. EfS carries with it the inherent idea of implementing programs that are locally relevant and culturally appropriate. Hence the design thinking programme is relevent for the South African context where students learn through real world projects that are context relevent.

3. DESIGN THINKING AND SUSTAINABILITY

Originating in design, but capable of being applied across a broad range of disciplines, design thinking brings a disruptive, game-changing potential to ways of working that have become routine and contribute to some of the challenges that face society. While the emergent of the concept of sustainability is based on the realisation that earth's resources are not limitless. Sustainability promotes consumption of products, services and systems that are developed driven by socially and environmentally benign while satisfying the user's needs. Furthermore, the development of systems, products and services that are better for society, have less impact on the environment. Furthermore, design thinking place emphasis on humans through gaining empathy for the users as well as the value of understanding the context and human place in it.

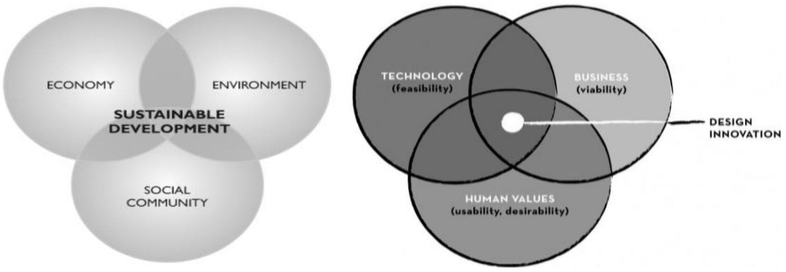

Figure 1. Framework for sustainable development and design thinking

Design thinking is a methodology for innovation that combines creative and analytical approaches and requires collaboration across disciplines. The process of design thinking draws on methods from engineering, design, and combines them with ideas from the arts, tools from social sciences, and insights from the business world. The students in design thinking programme learn the process in a team environment and internalised it, and apply it in their own contexts (Novak, 2011). Traditional education system promotes working in silos while working on tamed problems. Furthermore, the analysis of contextual, human-centered techniques to promote sustainable design of products, services and environments by holistically considering people, environment, energy, economics, and health is important. Design thinking merged with design for sustainability combines insights to provide a means whereby users of products, services and systems become inseparable partners in ensuring the longevity of our natural, social, and economic environments.

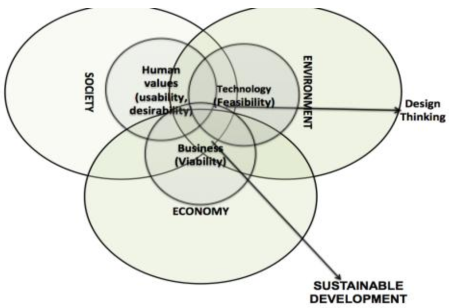

Figure 2. Framework juxtaposing Design Thinking on the Sustainable Development

While sustainable development focuses on society, environment and the economy, design thinking focuses on human desirability, technological feasibility and business viability which are all critical to development. When the sustainability principles are combined with the design thinking methodology can have more impact towards promoting and achieving sustainability.

4. DESIGN THINKING METHODOLOGY

Design thinking uses designer's sensibility and methods for problem solving to meet people's needs in terms of technological feasibility and economic viability (Brown, 2009). The methodology brings a process towards building sustainable systems, services and products. In education it is about creating transformative learning experiences to help students develop a process for producing creative solution and build creative confidence tackle complex challenges. Design thinking uses abductive reasoning. According to Kees Dorst abduction reasoning**,** is associated with 'problem solving' (Dorst 2006). Constructivist thinking considers abductive inference to be the only knowledge-generating mechanism (Fischer, 2001). Problems in abductive cognition appear to be spectacularly contextual (Mackonis, 2013).

"Einstein once said a problem can never be solved from the context in which it arose". In design thinking complex problems are solved by multidisciplinary teams with diverse views about the challenge help in generating solutions that have wider applicability. Educating students who can work in different context to those they have been trained is crucial for society to be able to solve the complex challenges. Design Thinking requires a shift in the mindset from working in silos to an appreciation of the power of teams and the diversity that the teams offer in terms of worldview, cultural perspective and education. Design thinking is action oriented in order for teams to fail fast and learn quickly from their mistakes.

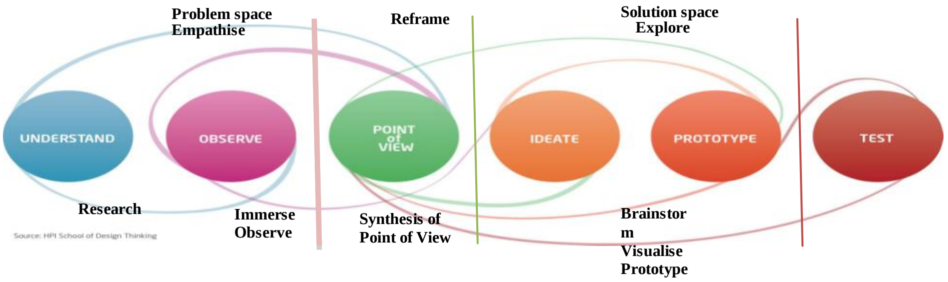

Figure 3. Design Thinking Process

Designers test their prototypes with the users in order to further their understanding of the problem and the solution. Therefore, an action-oriented mindset needs to become second nature and is fundamental for dealing with ill-defined problems (Buchanan, 2002). The experiential learning theory model juxtaposes two approaches to grasping concrete experience and abstract conceptualization as two approaches to transforming experience reflective observation and active experimentation which are both key to design thinking training (Beckman and Barry, 2007). The methodology is about using design tools to tackle more complex problems, rather than focusing on enhancing the look and functionality of products, it is about designing user experiences, instead of consumer products. It is about creating ideas that better meet the users need and aspirations, rather than making already developed ideas more attractive. Design thinking helps teams understand the value of constraints. When designers are dealing with a problem they take its constraints as suggestions and tend to think about underlying issues from a broader perspective (Norman, 2013).

5. BROADER PRINCIPLES OF DESIGN THINKING

5.1 Human-centered Approach

Human-centered design is a philosophy, not a precise set of methods, but one that assumes that innovation should start by getting close to users and observing their needs" (Norman & Verganti, 2012). Taking a human-centred approach shifts perspective from technical to one in which human biases and heuristics play a role, and where personal values, attitudes, beliefs, cultural settings are considered when designing solutions. Human-centered design takes a socio- technical view (Emery and Trist, 1960), balancing the requirements of two, competing “systems” (Hedberg and Mumford, 1975; Heller, 1989). Human-centered aproach advocates the design and development of flexible systems that permit the people who work with them to shape and manage their work (Gill, 1991; Kapor, 1996; Lehaney, Clarke, Kimberlee and Spencer-Matthews, 1999). Human-centered systems production should concern itself with the joint questions of "What can be produced?" and "What should be produced?" The first is about what is technically feasible, the second about what is socially desirable (Kuhn, 1996; Lehaney, Clarke, Kimberlee and Spencer-Matthews, 1999). In essence design thinking is not about what is, it focuses more on what could be?

5.2 Research Based

Design thinking applies qualitative techniques of information gathering such as ethnographic, interviews, observations and immersion into the context (Korn and Silverman, 2012). In 1984, Kolb pulled from these many theories of learning to build what he called “experiential learning theory” in which he defined learning as “the process whereby knowledge is created. through the transformation of experience,”as applying the four steps of experiencing, reflecting, thinking, and acting in a highly iterative fashion.

5.3 Design Thinking Looks at a Broader Contextual View

The design thinking methodology forces participants to unpack and understand that any system operates by interacting with its environment. Therefore, understanding the contextual view by describing graphically the interaction of the system with the various entities in its environment. The interactions consist of data flows from and to the entities. The contextual view clarifies the boundary of the system and its interface with the environment in which it operates. It also helps in expanding the challenge to a wider frame of reference. The innovation process is grounded in deep understanding of the context of engagement and use of a solution through the concrete analytical work done through interviews and observation (Beckman & Barry, 2007).

5.4 Collaborative and Multi-Disciplinary

Design thinking encourage the understanding of social interactions. It also serves as a valuable common language that diverse teams and groups of people can use to effectively collaborate on challenges and projects. With a multidisciplinary team, the solution that is developed is relatable to more people. There is always something new to learn when interacting with someone different from you. Design thinking is a multidisciplinary mindset regardless of whether design is directly involved or not (Buchanan, 1998).

5.5 Iterative Deliveries and Prototyping

Design Thinking is a creative human-centered discovery process followed by iterative cycles of prototyping, testing and refinement. Design thinking promotes the production of provisional outputs that can be tested with the user in order to develop understanding of both design problems and alternative solutions (Lawson, 1997). Design thinking can be likened to a good conversation, from which helps the team get a better understanding than where they started. Testing with the users allows for teams to learn fast from their failures. Solution evolves from a series of prototypes that helps to explore options (Boehm, 1986; Houde and Hill, 1997). Prototypes provide the means for examining design problems and evaluating solutions (Houde and Hill, 1997).

6. CONCLUSION

This paper looked at the design thinking methodology as a valuable process toward sustainably tackling the higher education challenge of training graduates are expert in their disciplines. Design thinking explores creative ways of problem solving which critical to dealing with some of the social challenges in society. The methodology gives none designers the confidence that the can be part of crating a more desirable future, and a process to take action when faced with a difficult challenge. The creative confidence is required in the education sector as it has to produce citizens who are ready to make a positive contribution to society and able to deal with complexity of the work environment. The next phase of this research will be to engage with graduates who have gone through the programme.

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NEW ECOLOGICAL PARADIGM AND SUSTAINABILITY ATTITUDES WITH RESPECT TO A MULTI-CULTURAL EDUCATIONAL MILIEU IN CHINA

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ABSTRACT

Institutions of higher education are increasingly interested in how the student experience may or may not influence world views and particularly with respect to sustainability. Here we report preliminary results from a New Ecological Paradigm (NEP) study in China to benchmark student responses, and we relate these results to findings from other studies in China and elsewhere. The 15-item NEP was administered to 265 students at Xi'an Jiaotong-Liverpool University in China, a Sino-British joint venture between research-led universities that confers both University of Liverpool and Chinese degrees and where the teaching language is English. We analyse item-by-item and aggregated results and find that, as expected, our study cohort, which is largely constituted of Chinese students, is unique in having a multi-cultural educational milieu, and results from our cohort differ from the comparison cohorts. Our cohort is aligned with a so-called Western world view with respect to Limits to Growth and Anti-anthropocentrism, however, differs from the Western view with respect to Balance of Nature. We find that the most relevant aspect for our purposes is to understand the causal differences influencing response from "high" and "low" responders within our particular cohort. Implications of these findings to education and the student experience are discussed.

KEYWORDS

Sustainability, education, environmental attitudes, New Ecological Paradigm, environmental culture change

1. INTRODUCTION

Universities often pride themselves in having a foundational and transformative role in society (Lozano et al., 2013, and references therein). However, it has recently been asserted that due to the slow rate of change and traditional nature of many such organisations, a present challenge for universities is to modernise with respect to sustainability and sustainable development (Lozano et al., 2013, and references therein). Institutions of higher education are increasingly interested in how the student experience might influence world views, and interest in sustainability in higher education is increasing. Sustainability education is particularly relevant in China given its recent history of economic growth and the government's ambitious plans for sustainable development. A recent Chinese study (Yuan and Zuo, 2013) on student perspectives with respect to Higher Education for Sustainable Development (HESD) conducted at Shandong University found that over 96% of students felt that they had some knowledge or knew very much about sustainability. As examples of the study's findings: a) over twice as many students strongly agreed that campus security was important to HESD in comparison to university accreditation via, e.g. the Global Reporting Initiative; b) in the overall ranking of considerations for achieving HESD, providing access for people with disabilities was top ranked (number 10 of 10), whereas reduction of toxic materials and radioactive wastes ranked 4; and, c) of six categories queried in the Graphical Assessment of Sustainability in Universities tool (GASU), awareness of the topic of environmental sustainability was lowest across all majors and year classes.

Economic development in China has proceeded at the cost of, in many respects, severe environmental degradation and pollution, and for many, increased income, price stability, social order, and education are prioritised over protection of clean air, natural ecology, and biodiversity (Harris, 2006). Chung and Poon (2006) have reported on how instrumental views of nature lead many individuals to believe that humans have the right to make any use of nature that they please and that human ingenuity in inventing technology will

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eventually effect a solution to current problems. This has been equated by Chang (2015) as a trend mimicking the dominant social paradigm of Western Society. It is important to explore this issue as attitude is part of culture, inclusive of environmental culture and how this influences environmental outcomes, sustainability, and sustainability education.

One well-known instrument used in recent years to research environmental attitude is the New Ecological Paradigm (NEP, Dunlap, 2008; Dunlap et al., 2000), results from individual questions of which have been used in aggregate to calculate student sustainability attitudes (Jowett et al., 2014). Here we report preliminary results from a study in China to benchmark student NEP response and sustainability attitudes and we relate these results to findings from other studies. We examine three types of cohort: 1) Chinese students from "traditional" Chinese Universities (data from Chang, 2015), 2) Chinese students within an international educational milieu (this study), and 3) students in a traditional "Western" educational milieu (data from Amburgey and Thoman, 2012). While results are preliminary, it appears there are potential differences between the three groups.

2. METHODS

The 15-item NEP (Table 1) was administered to 265 students at Xi'an Jiaotong-Liverpool University (XJTLU). XJTLU is based in Suzhou, Jiangsu, China and was founded in 2006 as a result of a partnership between the University of Liverpool and Xi'an Jiaotong University. It is the first Sino-British joint venture between research-led universities, and on graduating students receive a University of Liverpool degree as well as a degree from XJTLU; the teaching language is English. XJTLU's vision is to become a research-led, international university, with a mission to explore new models for higher education that will exert a strong influence on the development of education in China and internationally, and to conduct research in areas where humanity faces severe challenges. Our cohort is comprised of students across all majors at XJTLU[1] and represents a group that we anticipated might be interesting to study with reference to the unique educational environment at XJTLU.

Table 1. NEP Scale from Dunlap et al. (2000)

1. We are approaching the limit of the number of people the earth can support.
2. Humans have the right to modify the natural environment to suit their needs.
3. When humans interfere with nature it often produces disastrous consequences.
4. Human ingenuity will ensure that we do not make the earth unliveable.
5. Humans are severely abusing the environment.
6. The earth has plenty of natural resources if we just learn how to develop them.
7. Plants and animals have as much right as humans to exist.
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.
9. Despite their special abilities humans are still subject to the laws of nature.
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated.
11. The earth is like a spaceship with very limited room and resources.
12. Humans are meant to rule over the rest of nature.
13. The balance of nature is very delicate and easily upset.
14. Humans will eventually learn enough about how nature works to be able to control it.
15. If things continue on their present course we will soon experience a major ecological catastrophe.

For administration of the NEP, undergraduate students were provided with a paper instrument and asked to rate the level of agreement for each NEP statement on a 5-point Likert scale. Student respondents were also asked to provide, on the survey form, some additional sociodemographic information; applicable ethical procedures were followed. Average responses by item were tabulated for our cohort, and aggregated results, which have been used by others to characterize sustainability attitudes, were also examined. The approach to aggregation that we use follows results from factor analysis by (Dunlap, 2008; Dunlap et al. 2000) according to Table 2. NEP items were also summed according to the categories 1) "Environmental" (odd statement

[1]Architecture, Biological Sciences, Chemistry, China Studies, Civil Engineering, Computer Science and Software Engineering, Electrical and Electronic Engineering, English, Culture and Communication, Environmental Science, Industrial Design, International Business School Suzhou, Mathematical Sciences, Public Health, Urban Planning and Design.

numbers) and 2) "Anthropocentric" (even statement numbers) and an environmental / anthropocentric ratio calculated. In the next section, results are compared to published results from two other cohorts.

Table 2. NEP Aggregated categories from factor analysis

Aggregate Category	NEP Statements in Category (No.s)
Balance of Nature	3, 8, 13
Ecocrisis	5, 10, 15
Anti-exceptionalism	4, 9, 14
Limits to Growth	1, 6, 11
Anti-anthropocentrism	2, 7, 12

3. RESULTS – COHORT SIMILARITIES AND DIFFERENCES

Average responses to the NEP statements for three cohorts are shown in Figure 1 below. The two published cohorts we consider are from Amburgey and Thoman (2012, "Western cohort") and Chang (2015, "Chinese cohort"). The former of these consisted of 328 undergraduate students at the University of Utah, and the latter consisted of 1,148 undergraduate students, approximately half of which were from Lanzhou University (Gansu Province) and the other half of which were from Liaocheng University (Shandong Province), both in China. Generally, the level of precision makes it difficult to see statistically meaningful differences on a univariate basis, however, some preliminary observations can be noted. It appears that there is a tendency toward positive response bias from the Chang (2015) data, because the average response for all items is higher than for the other two cohorts, save for one item (6), despite that seven of the fifteen NEP items represent reverse Likert scaling. Thus, it is notable that Chinese students in Chang's cohort agree least with the notion that earth resources are limited (which echoes the findings of Yuan and Zuo, 2013, though no direct comparison can be made due to the different instruments that these authors used). The Chinese cohort's response to this item is about the same as for the Western cohort, whereas students from this study agree most to this item. Another two statements in which our cohort's responses were somewhat in contrast to the other two cohorts were items 8 (nature is strong enough to cope with human impacts) and 9 (humans are subject to the laws of nature), wherein our cohort take, respectively, a more or less "Environmental" (vs Anthropocentric) view. Other differences include that our cohort is in agreement with that of the Chinese cohort that the earth has plenty of resources if humans will only learn to develop same, whereas the Chinese cohort strongly agrees that humans were meant to rule over nature, with which the Western and our cohort, respectively, are neutral and disagree.

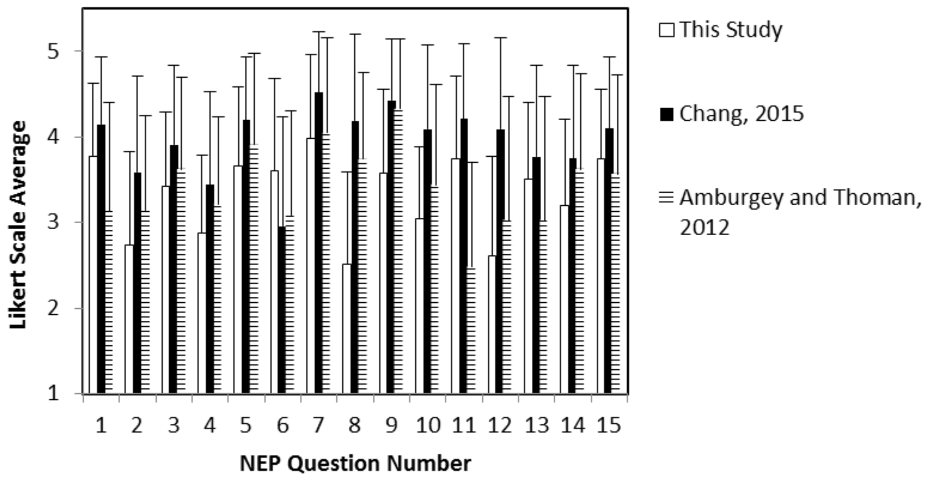

Figure 1. Average responses to the NEP statements for the three cohorts discussed herein. Average precision is ±1, expressed as standard deviation, with a minimum of 0.7 and a maximum of 1.45 and is relatively uniform across cohorts for most items

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Interestingly, when averaged by factor-analysis determined categories (Dunlap, 2000, Figure 2), strong opinions are more or less effaced across all cohorts (average response ranges 7.2-9.5 where 7.5 is neutral, 15 is strongly agree, and 3 is strongly disagree), with the Chinese cohort of Chang being consistently neutral, but slightly less environmental than the other two cohorts on these points. All three cohorts are most aligned with respect to an, on average, agreement that an ecocrisis is building. The largest ordinate axis value in Figure 2 relates to our cohort's generally agreeing that the balance of nature is upset by humans, followed by the Chinese and Western cohorts, respectively.

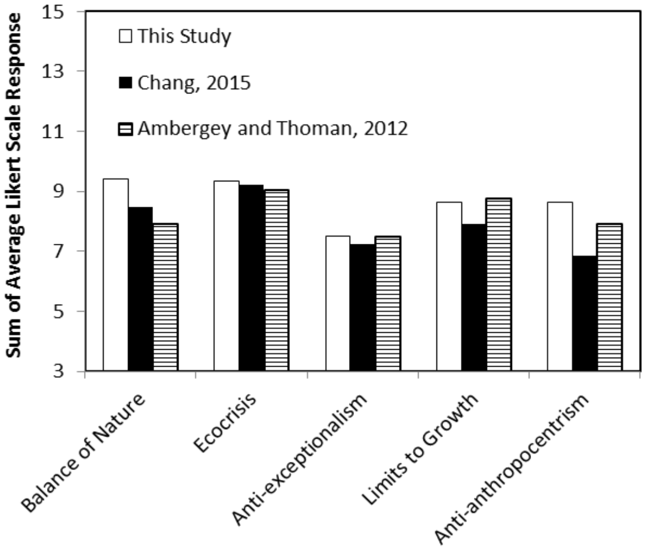

Figure 2. Average response according to aggregated categories representing overall sustainability attitudes

To try and understand more with respect to the specifics driving the attitudes of our cohort, we calculated a ratio of the summed response to "Environmental" versus "Anthropocentric" items in the NEP; this ratio is plotted versus cumulative percentile in Figure 3. Generally, viewed from this perspective, there is a smooth continuum of response with differences apparently most evident among a small number of students. The inflection points in this figure correspond to ratios of 1.11 and 3.15. Excluding all the responses in between these cumulative percentiles and replotting average NEP responses as a function of NEP item yields the graph in Figure 4. From this figure we see that there is little disagreement between "high" and "low" environmental responders for items 1, 3, and 11 (general agreement that we are approaching the limit of people that the earth can support, that humans may inflict disastrous consequences on nature, and that the earth does not have plenty of resources if humans can learn to develop same), and that the biggest differences are for items 2, 4, 6, 14, and 15 (whether or not humans have a right to modify the environment, humans can find a solution to problems, the earth has limited space and resources, humans can control nature, and we are on the verge of an ecocatastrophe).

4. DISCUSSION, LIMITATIONS, AND PRELIMINARY CONCLUSIONS

Various indications herein, as well as data not shown, suggest that our XJTLU cohort is different than the Western and Chinese cohorts – often with an intermediate world view, but sometimes differing from either. As results are preliminary, any conclusions must be viewed with caution. Irrespective of the preliminary nature of analysis of our results, many of the limitations and uncertainties in this study apply in a more general sense even for highly scrutinised and analysed data sets inasmuch as some authors question the utility of the NEP (see Sutton and Gyuris, 2015, for instance). Despite the NEP's shortcomings, it is arguably the most widely and longitudinally used instrument, and as such has value in terms of standardisation and transparency (Dunlap, 2008; Hawcroft and Milfont, 2010), and it would be difficult to argue that other instruments in development can be said to be demonstrably more material at the current stage of development, simply because of use history and available results.

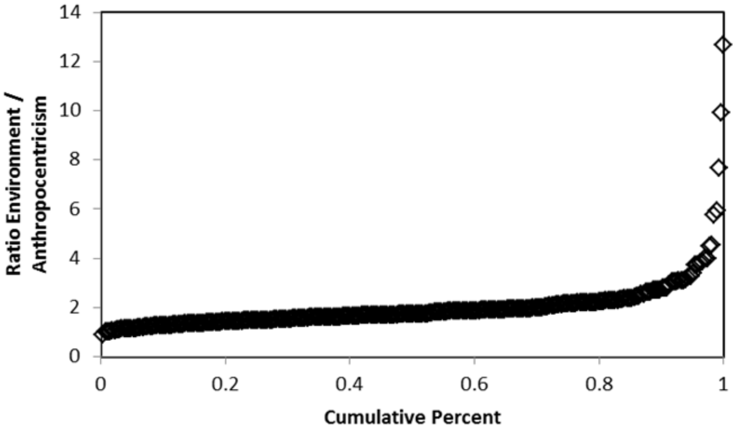

Figure 3. Ratio of the summed response to “Environmental” versus “Anthropocentric” items in the NEP versus cumulative percentile of response (this study)

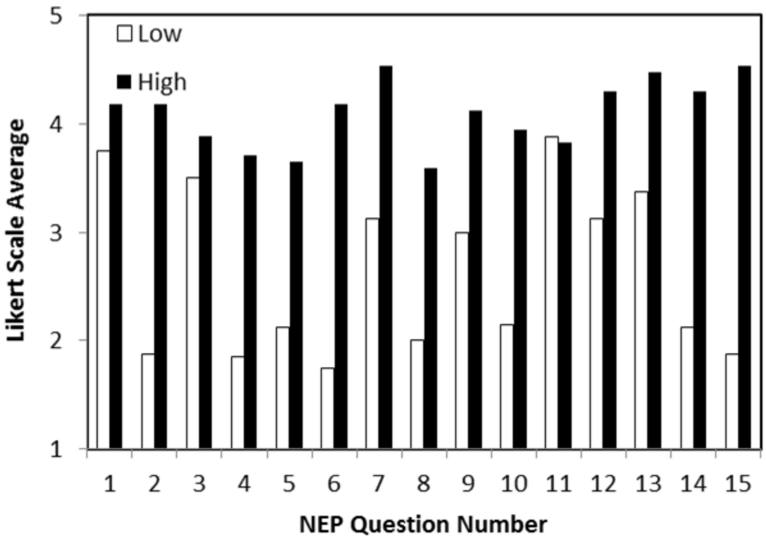

Figure 4. Average NEP responses as a function of NEP item replotted for “high” and “low” responding cohort members

Another issue to consider for any instrument is analysis of results. While the original instrument used here was to be used as 15 stand-alone items, subsequent work argues that the 15 items should be viewed as groupings (e.g. as demonstrated by factor analysis). While there is strong support for the five groupings that we use here (Amburgey and Thoman, 2012), plotted on the x-axis in Figure 2, other authors have argued for different groupings (Harraway et al., 2012). It is quite possible that the inter-relationships among items or the causal factors determining groupings vary as a function of perspective, for instance, cultural perspective. The method of data analysis for results shown in Figures 3 and 4, variations of which have been adduced by others (Jowett et al., 2014), suggest that such an approach deserves more investigation. For this work, Figure 3 suggests that the rankings of a small number of individuals in a population represented by the high cumulative percentile (“Environmental vs Anthropocentric”) might greatly contribute to variance in responses to individual items (per Figure 1), and going forward we will focus further on this aspect. First, if there is a normative “majority”, this would be helpful in better understanding differences in central tendency between different groups, which would increase the potential utility of the NEP as an instrument. Second, it would be further interesting to understand the influences contributing to the perspectives of individuals in highly differentiated subpopulations in terms of understanding the provenance of environmental culture.

This question of culture (Western, Chinese, Environmental, Anthropocentric, etc.) is undoubtedly an important element of environmental world view and to some extent or another engagement in issues relating to sustainability and behaviours relating to sustainability. Slimak and Dietz (2006) have reported results indicating that the NEP has a role to play in better understanding relationships between personal values, beliefs and risk perception. From our results it is not clear to what extent so-called Western versus Chinese world views influence environmental culture, however, the issue of what drives the differing perceptions of high and low responders within our cohort are of greatest interest if we wish to understand drivers to attitudes that relate to sustainability education. With this in mind, we are undertaking focus group exercises to better understand the causal influences of such differences, and we hope to report on this in due course. Aside from the overarching question of environmental world view, culture, and environmental behaviour as relates to sustainability, our studies to date indicate that, as others have found, the NEP is a useful tool to benchmark and subsequently track how environmental world view and associated sustainability attitudes change during the course of university education.

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Reflection Papers

SYNTHETIC BIOLOGY: KNOWLEDGE ACCESSED BY EVERYONE (OPEN SOURCES)

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ABSTRACT

Using the principles of biology, along with engineering and with the help of computer, scientists manage to copy. DNA sequences from nature and use them to create new organisms. DNA is created through engineering and computer science managing to create life inside a laboratory. We cannot dismiss the role that synthetic biology could lead in solving the most pressing problems of humanity. We are using technology to control live organisms and use them as we wish. But how should that knowledge be accessed? And which way is the best way so everyone can benefit from this technology and its developments? Open sources software could be the answer.

KEYWORDS

Synthetic Biology; Intellectual Property; Open Source

1. INTRODUCTION

Now days the human being can travel to the space, read genetic information about DNA and create new live organism inside a laboratory. Yes, the human being is capable of creating life inside a laboratory. Perhaps the times described in the work of Mary Shelley's Frankenstein of 1818 where Victor Frankenstein created life in a laboratory have come true. Synthetic biology is the responsible for this.

Using the principles of biology, along with engineering and with the help of a computer, scientists manage to copy DNA sequences from nature and use them to create new organisms. DNA is created through engineering and computer science managing to create life inside a laboratory. We cannot dismiss the role that synthetic biology could lead in solving the most pressing problems of humanity. We are using technology to control live organisms and use them as we wish. But how should that knowledge be accessed? And which way is the best way to access them so everyone can benefit from this technology and its developments?

2. BODY OF PAPER

Synthetic biology "broadly refers to the use of computer-assisted, biological engineering to design and construct new synthetic biological parts, devices and systems that do not exist in nature and the redesign of existing biological organisms, particularly from modular parts" (Internationl Civil Society Working Group on Synthetic Biology, 2011). In simple terms synthetic biology is an interdisciplinary subject that is used to make DNA from scratch to create live organisms. Synthetic biology promises to "design and build brand-new biological systems to eradicate deadly diseases, manufacture better material and reduce reliance on nonrenewable resources" (Draxler, 2013). Synthetic biology is a very important theme of rapidly growing industrial interest that involves science and technology.

So now we are already creating it. How should it be protected and regulated? Organisms created by synthetic biology are organisms that can probably reproduce naturally without there being human will. The products of synthetic biology are very complex; they should not be treated as a mere and simple invention. It is uncertain on what these organisms can be converted to and whether they represent a contingency for human health or the environment. Despite this, as of today there has not been developed an ad hoc figure that provides the necessary protection and care for a product created by synthetic biology.

Products created by synthetic biology are protected by intellectual property. Two main models of intellectual property are used to protect synthetic biology components, organisms and products: patents and open source software (Calvert, 2012). On the one hand, synthetic biology can be patent just by meeting the simple requirements set by the country-specific legislation. There is a universal agreement among nations that patents should not include abstract ideas, laws of nature, physical phenomena and products of nature. Usually the country-specific also asks for these requirements to be met: novelty, usefulness and non-obviousness. If a product created by synthetic biology fulfills these requirements is patentable. So we can expect that every product created under synthetic biology will be patent just by the mere fact of being created by synthetic biology. A product of synthetic biology is something new that will not be founded in nature, will be something that is not obvious and will have a specific use for which it was created.

The patent "confers on a patentee power to exclude all other from making, using or selling his invention (Baxter, 1966). But this patent can become a monopoly. And if it constitutes a monopoly it will bring "insufficient disclosure of the invention; lack of use or inadequate use of the patented invention; and abusive practices in licensing agreements" (Roffe, 1974). Such a complex and promissory subject as it is synthetic biology cannot afford to have those issues.

On the other hand, open source "describes a set of rules and practices for defining a community of developers through which information is freely disclosed and distributed" (Anderson & Oderkirk, 2005). Open source software are computer software in which the copyright holder provides its rights to everyone and must permit non-exclusive commercial exploitation, must make available the work's source code and, must allowed that its work be developed (St. Laurent, 2004).

As we have explained patents might not been the right mechanism to protect the products of synthetic biology. The patent may be restricting the innovation and knowledge from others. Faced with the challenges we've seen raised by synthetic biology we needed to analyze whether it is necessary to flex the use of patents through the use of open sources (Conde, 2012). These open codes allow you to use a "patent" invention without any obligation to pay for the use of the invention, as long as the outcome of the investigation for which the "patented" invention is used is published in open sources.

Authors like Kumar Rai and Henkel and Maurer have studied this mechanism and believe it would be very useful for synthetic biology as it seeks to exchange different inventions based on the use of synthetic biology with the goal of creating interchangeable and regularized genetic parts (Rai & Boyle, 2006). A model of intellectual property based on open-source software may lead to greater innovation, transparency, and openness (Calvert 2012).

However, implementation of patents and open source software are not an easy task. These intellectual property models for synthetic biology could have a variety of impacts on biodiversity. Convention on Biological Diversity identifies "new and emerging issues relating to the conservation and sustainable use of biodiversity" (CBD Technical Series No. 82, 2015). So under this premise it is that we should analyze the possibility of protecting the products of synthetic biology under open sources.

The Convention on Biological Diversity aims for "fair and equitable sharing of benefits arising out of the utilization of genetic resources" (Lehman, 2008). From here the need to find a mechanism that works like a link between the Convention and intellectual property rights in order to ensure transfer of knowledge. There is a need to research this field in order to achieve and to analyze the access to genetic resources and sharing of benefits of synthetic biology in light of intellectual property.

Following this path is that the first problem arises. The right of access to genetic resources and sharing of benefits often combines with the intellectual property rights to use patents, but these patents can represent a barrier to access new technologies created under synthetic biology. This is where we presented the eternal disagreement between those who argue on one hand, that patents are an obstacle to the right of access to genetic resources and on the other side, those who believe that patents are intended to encourage innovation in the development of new technologies (Andermariam, 2007).

Companies now days rather that contributing to knowledge in synthetic biology are restricting it by patenting their findings. In a subject as complex as synthetic biology and were one DNA-sequence must be needed in order to help other scientists develop their research, knowledge cannot be restricted. Scientists should work together in an open mechanism to share genetic information that can help resolve the most pressing problems of humanity.

Synthetic biology represents a challenge to the intellectual regimes that exist today. They represent a challenge for three things: (1) the organisms in synthetic biology evolve, (2) the traditional relationship between the product and the risk of synthetic biology are not the same as a normal product and (3) the regulatory approach of conventional existing laws on the final product of chemicals in the case of synthetic biology tends to be very poor to regulate a technology that produces new organisms with its own risks (Mendel & Marchant, 2014).

So you cannot expect the regulatory system that we have today in intellectual property to regulate synthetic biology correctly. In fact, it is believed that in United States the legislation that exists today is not able to fully adapt to what is synthetic biology (Rai & Boyle, 2006). So we can expect the same thing happens in the entire world on matters of intellectual property, since there have not been any world-legislation on intellectual property that regulate synthetic biology.

3. CONCLUSION

So, how should knowledge in synthetic biology be accessed? And which way is the best way to access it so everyone can benefit from that technology and its developments? Open sources are a promising way that can answer our questions in matters of intellectual property.

In a world were everything is changing very quickly and were man wants to control everything including life itself, something as important as what synthetic biology may imply needs to be regulated. Or at least may have a specific way designed to be followed. Open sources should be established as a specific and regulated way to benefit from the knowledge provided by synthetic biology. If doing so, everyone will be able to access knowledge in a transparent way. And everyone will be able to benefit from it and continue developing the discoveries founded under this field.

For some, open sources may be a limitation because they will not be able to profit from it. But something as important as life itself should not be a matter of profit. And that is what synthetic biology is about, creating life and managing the fundamentals of the human being.

Open sources should be applied in all fields of synthetic biology; by doing so it would enable research to develop more rapidly by putting in dispocition of everyone knowledge.

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ENVISIONING THE CITY OF THE FUTURE: KNOWLEDGE SOCIETIES VS. ENTERTAINMENT SOCIETIES

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ABSTRACT

The envisioning of the city of the future deals with several considerations in regards to economic, political, educational and social welfare. We are increasingly living in a world full of information, but that still lacks of some basic instruments to become great in respect of human welfare, dignity and knowledge. A vision of a 21st century modern city is presented in this paper as part of a global vision that tends to ideologically encourage the creation of knowledge societies but that in reality is creating something else, a paradigm of what some scholars have called "entertainment societies".

KEYWORDS

Entertainment Societies, Knowledge Societies, Human Rights, Modern Cities, Social Welfare, Technology

1. INTRODUCTION

Throughout history, several cities have been recognized as the most important of their time since they depicted vanguard, whether that was in social, political, demographic or economic terms. Great examples of that are the old Athens and Sparta, Alexandria with its marvelous library, Babylon or Jerusalem. Back then, the notion of "city of the future" was forged around the possibility of maintaining an autonomous and self-sufficient social order that could satisfy the basic needs of an increasing population. One could argue the same basic idea is still valid in our times, but there are some specific aspects to point out. Such considerations will be briefly described in this paper.

2. BODY

Before the modern State was defined, cities planned their activities around the fulfillment of the needs of the population as proof of independence and self-sufficiency versus other cities and civilizations; in other words, they looked after their problems only to show their capacity to manage themselves internally. As social and political structures transformed by the end of the 19th and beginning of the 20th century, within the frame of the modern State, cities were obliged to guarantee the satisfaction and resolution of some basic needs and problems of their inhabitants, clearly shown by 2 major concerns:

a) The safeguarding of social welfare by the means of public activity, and the satisfaction of particular needs (security, sanitation, trash collection, public lighting, to name a few), and
b) The satisfaction of the needs of groups in relative economic disadvantage (with emphasis on extreme poverty, indigents and children living on the streets, among others).

This vision of guardian of social welfare and guarantor of some minimum living conditions is what should prevail in modern cities in the 21st century with knowledge societies; and it is through the municipal sphere that an effective response can be achieved to fulfill the needs of individuals. Cities of the future must have a very close relationship with their inhabitants to know what the public needs to satisfy are, and they also should have the right mechanisms to do so. This can be achieved by contemplating different angles within the political and legal systems, such as the rational and optimal use of resources, the establishment of urban sustainability through strategic planning, and by encouraging a service economy, just to list some.

The understanding of these needs led me to appreciate the equally important roles that disciplines like finance, law, and economics play in the knowledge societies and in the innovation process for human kind. Yet, innovation itself is a necessity more than a luxury: companies do it for profit, but mankind needs it for long-term survival.

Along with the search for alternative and renewable energy sources, modern society faces a swath of tough challenges that are trans-disciplinary in nature. In the sake of sustainability, the future to come has to witness a rethinking of the infrastructure and systems employed to provide transport, nutrition, housing, education and healthcare to a population of over 7 billion.

As I mentioned earlier, companies innovate for a profit, and so much of this systems overhaul I refer to has been the result of the creative coupling of new and existing technologies to gain economic or strategic advantage in a determined market. Nevertheless, I believe a much more methodical approach could and ought to be followed, one with central focus in addressing the shortcomings of current societal systems and that, much like economics, considers the micro- and macro- impacts of technical solutions and their implementation. This approach —which I deem critical in a world craving for sustainability— is what I want to advocate for through research that not only drives the policy-making process, but that identifies the means to put innovation into effect, whether through creative new businesses, state sponsored schemes, public-private partnerships or combinations thereof.

But, how on earth does the knowledge societies may come to exist if the cornerstone represented by fundamental rights do not appear within the information societies?

I would argue that as modern societies we need to request the United Nations to call for the enactment of an International Pact on Human Rights; we would need to demand such document to include the principles contained in the International Covenant on Economic, Social and Cultural Rights, as well as the content of the International Covenant on Civil and Political Rights.

This premise shall be formulated based on the universal principle of human rights, as well as in the idea of generating a culture of respect towards them with no special hierarchy. Vienna’s 1993 World Conference on Human Rights was designed to solve the problems in the adoption of the previously mentioned agreements, by establishing that all human rights are universal, indivisible, interdependent and interrelated. However, it seems to me that in reality, the international community does not treat human rights in a global, fair and equitable way, weighting and respecting them all equally.

By proposing to group together the contents of both Covenants I referred to before in an International Pact on Human Rights, I would be aiming to homogenize in one single international document such freedoms, arranging them alphabetically, with no hierarchy and in a whole unit of obligations for the member States of the United Nations. This might be seen as just a semantic matter, but giving order to the Universal System of Human Rights would mean proof of a real concern and interest in achieving the efficient protection of human dignity, as well as the advancement of fundamental rights in the XXI century.

In addition, we should advocate for new technologies, policies and businesses that address the deficiencies of contemporary human systems in a variety of fields.

But while doing so, we cannot continue to reduce the humanities and the arts from primary and secondary schools in order to let the technological approach to prevail. As Martha Nussbaum states:

“We are in the midst of a crisis of massive proportions and grave global significance… Radical changes are occurring in what democratic societies teach the young, and these changes have not been well thought through. Thirsty for national profit, nations and their systems of education, are heedlessly discarding skills that are needed to keep democracies alive. If this trend continues, nations all over the world will soon be producing generations of useful machines, rather than complete citizens who can think for themselves, criticize tradition, and understand the significance of another person’s sufferings and achievements. The future of the world´s democracies hangs in the balance.” (Nussbaum, 2010).

Consequently, societies are not becoming learning societies. Technology is thus a tool for entertainment and not for transformation of information into knowledge, and of knowledge into more and new knowledge. Citizens’ lack of academic and cultural means to take good and informed decisions that could permeate into society through public policies are in scarcity mode.

It could be argued then that “the internet [and social media technologies] can therefore… become both an instrument for the building of knowledge societies and a labyrinth that will lead us slowly but surely to the shores –enchanted or disenchanted – of the entertainment society.” (UNESCO, 2005).

In general, countries worldwide and international organizations do not know how to make the technological division between the industrialized and the under developed countries. But even within the developed countries, we often discover that the information societies are compromised since their inhabitants are not capable of filtering the huge amount of content, data and information they are surrounded by. Such citizens do not present the necessary skills to learn by classifying and selecting the appropriate information.

In my view, so far there is no social inclusion for learning and for building knowledge societies through the use of technologies, social media and social networking. We strongly require to turn back to traditional ways of learning, which usually include firsthand knowledge acquisition for developing democratic and mathematical skills to select adequate information, that will allow us to create accurate knowledge and to produce intangible capitals in our particular environments.

3. CONCLUSION

More personally, I see a city of the future as one that listens to the call of their citizens, gathering their input on the common problems; what I am thinking here are the likes of deficient public transport, access to drinking water or even food supply. A city that faces these everyday problems through dialogue, listening to the proposals emanating from its citizens, based on scientific and technological developments and with a solid legal system that safeguards their fundamental human rights, is what I would call a city of the future in the 21st century, thus a city with a knowledge society.

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BLUE OCEAN STRATEGY FOR HIGHER EDUCATION

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ABSTRACT

In today's higher education world we see a shift in teaching and educational trends that are slowly materializing due to the advent of new technologies, new academic frameworks and the need to adapt to society's incremental advancements. The implementation of reforms, however, did not have the desired outcome since those were applied to an education system that currently still mimics the XIX century Prussian system. There is the need for blue-ocean creating, disruptive innovations that can be sustained in new business models, which can holistically cater for education while rejecting past traditional higher education structures.

KEYWORDS

Education, IT Alignment, Blue Ocean Strategy

1. INTRODUCTION

The present education system should not be based on a Central European framework, which is centuries old. The Prussian system, however, has never been discarded in spite of its obsolescence. This means that education reforms have been repeatedly recycled in order to catch up with all the new technological advancements that have been made available to the public. This approach has been widely unsuccessful and has created a certain frisson between all stakeholders. It has promoted a misalignment in several sectors by hindering the cooperation between the technological environment and the socio-economic environment. New business models based on blue ocean theories might affect positively the status quo and create synergy between all stakeholders by enforcing a healthy interaction between both environments.

2. STATUS QUO AND PROBLEM ANALYSIS

Educators work in a platform that has not changed structurally since the XIX century. The world, however, is in constant mutation. The most recent technological trends managed to influence how we behave, learn and communicate with each other. A massive amount of information is now available anytime and anywhere. The way education is delivered should have changed in function of that but it did not due to a growth mindset problem. Even though the people running higher education institutions were forced to add technology to their modus operandi, they were inflexible when it comes to making structural changes. Presently we see technology being used as a tool to double up processes or to merely digitize old practices, which are routinely performed inside or outside the classroom environment. We have seen generational clashes hindering disruptive change. The older generation, which is normally hierarchically better positioned, has a generalized belief that academic processes have to be run in a specific way and be done as it has always been. They express an aversion to change characterized by the fear of not being able to adapt and the excuse that it is not reliable to use *unproven methods*. This creates a misalignment between processes (Rockart&Scott Morton's Framework, Appendix). "Yet alignment can be difficult for IT leaders in higher education to achieve. The heart of information technology's alignment with an institution is a common understanding of that institution's priorities. But higher education's idiosyncrasies cloud the process. Individual colleges frequently operate as independent entities, creating distinct organizational cultures and managing many academic, research, and administrative activities locally." (Pirani, J. and Salaway, G., 2016). In spite of the many challenges there is a pressing need for systemic change coming from all sides illustrated in the framework mentioned previously. This becomes extremely hard to do in the region where I currently work since the Middle Eastern Gulf Region is new to these types of old processes and expresses an inclination to eagerly adapt and follow blindly the majority of Anglo-Saxon based frameworks, which end up being shaped or altered by local culture before its implementation. These cultural adaptations or alterations do not create value and end up provoking several unwanted bottlenecks most of the times. In order to implement new technological trends and use the "latest" educational practices, (i.e. constructivism, flipped classroom approach, active learning, etc.) it is imperative to revamp traditional structures. I can give a few examples to illustrate how does this translate to in my reality. I found situations where I observed a lecturer reading from keynote slides featured on interactive smart-boards while students were browsing unrelated content on their tablets. I have witnessed colleagues enforcing in-class online quizzes, which mimicked the paper format and brought nothing new to the learning experience since it is more than obvious nowadays how redundant traditional assessments have become. I have debated the validity of unexclusive course related content being uploaded over and over again on learning platforms while students can access it online freely. I have coped with management forcing lecturers to deliver grades and feedback using several online and offline platforms at the same time, which ultimately kept creating redundant admin work. If we endure this on a daily basis we can easily understand that technology did not revolutionize education. I believe it is slowly having the opposite effect. While I understand it is important to rely on structured education we cannot ignore the status quo. To make matters worst Higher Education institutions are not focused on preparing students for the world of the future because there is no real interaction between the institutions and the labour market. Many might see this as a generalized erroneous statement since worldwide many departments do liaison with the industry, however, when it comes to mass communication, new media, sound, film and other higher education based VET (vocational education and training) related disciplines this surely is not the case. If we focus on the MENA (Middle East and North Africa) region then these issues become even more relevant. These institutions have been disregarding potential collaborations with stakeholders, which could help creating shared value and promote a change in mindset. I have also witnessed a growing disconnect between academia and potential students from specific social strata and mature age groups. If we combine this with an increasing number of dropouts, who cannot relate to the current system and prefer to become autodidacts by using free online resources, then we can assume that there is ample room for improvement. I believe there is space for blue ocean strategies in academia. What does, however, the term "Blue Ocean" mean? It is a term coined by professors W. Chan Kim and Renee Mauborgne, which means uncontested market space. The idea is to go from a saturated market place ("red ocean"), where companies compete fiercely for market share, and flow into a blue ocean model that focuses on high product differentiation with limited costs. This seems unavoidable since "according to Larry Ladd, Grant Thornton's director of national higher education practice, only 25% of university administrators believe that the current business models will be sustainable for more than five years." (Dennis, M. and Lynch, R., 2016) Thus how can we move academia towards a "blue ocean" scenario? I believe the answer might be in Kevin Carey's "university of everywhere". This transformation will naturally take place due to IT's inherent potential but will not mimic entirely Carey's utopian description of a free for all, technologically backed, long distance, holistic educational experience. Carey's ideas might be flawed when it comes to providing a lens into the future; however, it is undeniable that big data and the Internet of Things can result in mass curricular customization and become a strategically savvy, personalized tool, which will enhance the learning environment. "As universities seek to transform in response to fiscal realities, new customer dynamics and technologies, some are recognising that the challenge is like starting a new venture built on 100 year-old infrastructure." (Dennis, M. and Lynch, R., 2016) From what I have exposed so far I think that there are unmet needs. While materializing and implementing a solution for those needs we might end up creating demand and value at the same time. We can do this by innovating in a way, which will make the competition inapt while untapping unequivocal terrain. "The next generation of students will not waste their teenage years jostling of spot in a tiny number of elitist schools. Their educational experience will come from dozens of organizations, each specializing in different aspects of human learning." (Carey, K., 2015) Brick and mortar institutions will not disappear entirely. Nonetheless expecting to rely on public/private funding and student fees for survival seems surreal under the current business model. Moreover it is unlikely that, in the future, researchers will continue to deliver content to undergrads in a stale, passive and inefficient way. Traditional academic denominations and paths might become extinct since, in the near future, with the developments in artificial intelligence and the information extracted from big data, we might create immersive learning experiences by gathering worldwide knowledge and packaging it in new learning environments. This might seem challenging in the western world but it is even harder in societies with strict social constraints. I work in the UAE's most prestigious federal university, which bears a rigid hierarchical structure in a highly contextualized culture, where the major concern is, as mentioned previously, to follow proven western educational standards without losing cultural identity. This means that in spite of the issues that education is facing worldwide, we still need to cope with gender segregation, religious idiosyncrasies and engage in a *glocalized* implementation of the future to come. The interesting catch is that western education has been struggling with its own character. Its strategy for the future needs to be renovated and thus it can no longer be used as a solid example for others to follow. I have been describing the problems and hinting at generalized frameworks in order to fix or rearrange the reality we are presently facing. I have been doing this, however, without providing any actions or recommendations. Is there any way we can improve higher education in order to prepare it for the real world in the future?

3. RECOMMENDED ACTIONS

In order to help solving the issues highlighted previously we need to understand the technological world and see how it can be useful for education. We need to address the people that are currently being overlooked by decision-making academics and high level higher education strategists. We should use corporate social responsibility in our favour and create partnerships between industry and academia. This would be especially relevant for the fields of expertise that I have mentioned previously and in the regions of the world, which are still resistant to this type of approach. How can we see this happen in reality? Ensure there is a branded presence on the Massive Open Online Courses Community (MOOC). The best universities are using this to cater for autodidacts. It helps lowering education costs; it promotes collaborative-shared value for society and helps boosting the university's brand name. It might also help sway potential education migrants to make a decision regarding future physical enrolments. Online Massive Open Online Courses should be made available for free but the university can capitalize on a gated online community where additional exquisite content followed by instructor counselling and guidance is provided for a fee. This is an excellent solution to tap into the mature learner's market and corporate training. The first two can only be achieved if there is a strong partnership with companies, which are *socially aware*. Higher Education institutions need to be able to understand what companies want students to learn before entering the job market of the future. It is essential for industry representatives to be part of curriculum development especially when it comes to the VET sector. There should be an added contribution from the industry by delivering pro bono master classes and a proactive engagement in curricular internships since this will give them the opportunity to interact with potential future employees. Online/offline class formats and delivery approaches need to be adapted to industry accredited standards while working in synergy with the latest educational practices, which were mentioned previously. It is not farfetched to aim for a recreation of the industry environment and its challenges in the classroom, especially in fields with a strong practical component. Transforming academic research by shaping it in the same way as the creative commons[1] community did will also help immensely. This will boost collaboration between academics, soften competitive aggression between academic institutions and promote knowledge growth with sustainable value creation. Even though research shows that MOOC's success has not reached the adoption rates previously forecasted, we have several success cases, which we can learn from, such as Lynda.com, Khan Academy and Minerva Schools. Minerva, most notably, is taking a lean approach to education. Elitist as it may be, this school is stripping out well known academic inefficiencies and taking a holistic approach to technology in a way that uses MOOC's as a means to an end instead of competing with it. Minerva is a clear example of an academic institution currently navigating in a "Blue Ocean". It has several campuses around the world, which promote cultural and intellectual interchange as well as student mobility. It enforces real world skills with a customizable curriculum and it is completely student centric. Its classrooms are small in numbers and its in class modus operandi relies mainly on an implementation of deep cognitive tasks which has been proven to be highly efficient but rarely enforced systematically in a classroom context before. (Craik, F. and Lockhart, R., 1972)

[1] The Creative Commons license allows for expansion, co-creation and sharing of creative work under a legal umbrella. Merkley, Ryan. 2001. *Creative Commons*. [ONLINE] Available at: https://creativecommons.org. [Accessed 23 February 2016].

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4. CONCLUSION

I believe these blue ocean strategies can be implemented in the western world especially in the private education sector. It will probably be the most sensible interim step before an “Artificial Intelligence/Big Data revolution” takes place. I feel that there will be some *frisson* in the public sector due to its inherent nature but time can heal potential growing pains if new generations of educators and managers are interested in promoting change and growth in untapped market areas. The question is, however, are countries in emerging markets prepared for these changes? Can this be done in countries such as the UAE where cultural sensitivities and stiff working ethics need to be taken into consideration?

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APPENDIX

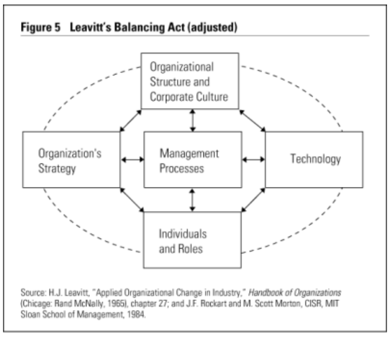

Figure 1. Rockart&Morton’s Framework

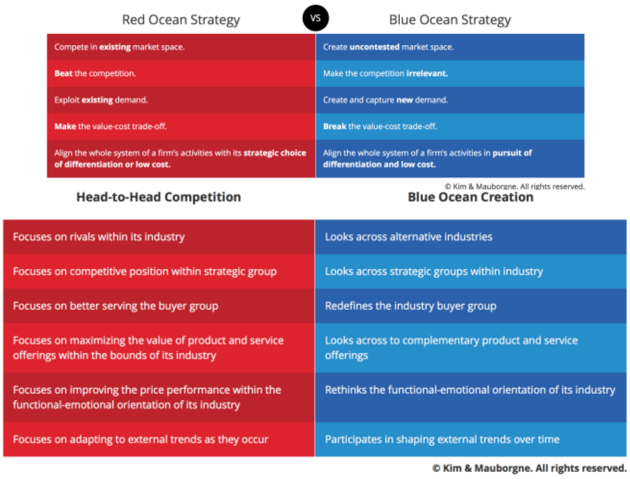

Figure 2. Red ocean vs. blue ocean strategy: competition vs. creation

EXPLORING HOW DIGITAL MEDIA TECHNOLOGY CAN FOSTER SAUDI EFL STUDENTS' ENGLISH LANGUAGE LEARNING

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ABSTRACT

Digital media technology has become an integral part of daily life for almost all young students, and for the majority of Saudi EFL (English as a Foreign Language) students. Digital media technology may not be limited to one or two kinds; it has various types such as software and programs, devices, application, websites, social media tools, etc. In addition, Saudi Arabia has a substantial young population who are becoming more digital-savvy and increasingly connected through digital media technology, which may include social media tools such as Facebook, Twitter, and YouTube, mobile devices such as smart phones and tablets, and websites such as Google Translate, just to mention a few.
Recently, it has been widely seen that digital media technology has greatly influenced education practices in many countries, especially in economically advanced economies. Due to the novelty of digital media learning, there is a pressing need to consider the integration of digital media technology to enhance contextual and collaborative language learning practice outside of the school, and to capitalise on out-of-class language learning opportunities.
The purpose of this study is to explore the extent to which digital media technology can enhance intentional language learning outside of the school. To accomplish the research aims, a mixed-method study will be conducted to achieve its goals. Quantitative research tools (a questionnaire) will be utilised to collect the data. This questionnaire will be designed electronically through Survey Monkey. It will be distributed to Year 12 Saudi male students in 20 high schools in two different areas, metropolitan and rural. The aim of choosing these two areas is to be an attempt to also explore whether digital media technology may influence intentional language learning amongst students living in different areas. On the other hand, qualitative data will be obtained from focus-group interviews with those students. Four focus-group interviews will be organised after administrating the questionnaire. Moreover, online weekly journals will be employed to triangulate the data.

KEYWORDS

Education Technology, digital media, intentional learning

1. INTRODUCTION

Digital media technology is used as an important tool in Education, and in specific to teach and learn English as Foreign Language (EFL) around the world (Barrett and Sharma 2007; Kern 2006; Yi 2012). Social and cultural factors can impact how digital media is utilized in education and this is particularly evident in Saudi educational systems (Al-Ahaydib 1986; Al-Saggaf 2004; Al-shehri 2012). A significant factor in the Saudi educational system is that students from Kindergarten to Year 12 are not allowed to bring and use any personal digital devices inside the school. Therefore, it is important to investigate the influence of outside-of-school intentional use of digital media in educational practices at year 12 level, as a sample of Saudi EFL students.

1.1 Background of the Study

Around the world, English language learning as a foreign language continues to be an increasingly popular and significant area of education. Previous research suggests that EFL classrooms in many different countries - especially the Middle East - are generally teacher- centred (Al-Saggaf 2004). The mode of teaching and learning is didactic with students often consigned passive roles (Al-Fahad 2009; Al-shehri 2012; Chen 2007), and are often predominantly 'in-class' learners, with little systematic study taking place outside of the school (Al-shehri 2012; Chen 2007). Consequently, some researchers (Ito et al. 2008; Kolb 2008) have posited that young people might well be engaging in tacit forms of English language learning through the process of using digital media technologies.

The growing interest amongst Saudi education professionals and policy makers for exploring the potential of digital media for English language learning necessitates a research study to address the intentional digital media usage among Saudi EFL learners (Chao and Chen 2009; Nassuora 2012; Phuangthong and Malisawan 2005). Such a study should investigate the extent to which intentional digital media usage may foster their English language learning. Moreover, language learning through digital technologies is not limited to time and place; synchronous and asynchronous learning can take place regardless time and space (Livingstone 2012; Selwyn 2011). It is evident that digital media can be used in any educational field and in any context (Al-Jarf 2014; Jarvis 2013). Therefore, this study will explore how digital media can play a significant role in fostering English language learning among a sample of Saudi high school students.

1.2 Rationale of the Study

Some EFL students may have a desire to use digital media technology to improve their English language abilities outside the school. Investigating the impact of the external environment on the improvement of EFL intentional learning and the language use is very important (Al-shehri 2012). Students may need practice to be successful self-regulated learners. They may also need to have more freedom from the traditional teacher-centred style of teaching to practice the language in their everyday activities.

Within the Saudi context, there is a rapid growth of using new digital media technologies; there are also local needs of Arabic youth with regard to English learning (Al-Ahaydib 1986; Al-Fahad 2009). Moreover, (Haq and Smadi 1996: 311) noted that Saudi students look at English language learning as "an instrument for cultural and technological transfer and advancement." This study is expected to shed light on how Saudi EFL students can benefit from digital media use to intentionally foster their English language learning outside of the school. Understanding how digital media is used among Saudi high school EFL students could provide insights into how to improve the learning experiences for students in the Saudi context using digital media.

2. LITERATURE REVIEW

This study will be conducted in Saudi Arabia among EFL students. Therefore, it is essential to have a brief overview of the context of learning English as a Foreign Language in Saudi Arabia.

The beginning of EFL teaching in Saudi Arabia can be traced to the mid-1920s (Al-Ahaydib 1986). Around 1958, English was taught in selected schools in Grades 7-9 (Al-Abdulkader 1979). Since 1970, English has been taught in Saudi public schools from Grades 7-12. Currently, English is widely used in the Saudi community, including in many business organizations. Within the huge and widespread of using digital media technology, English language in the Saudi context has become more prevalent, especially among young people who have greater potential to use these new technologies in their daily lives for intentional learning purposes.

Several researchers attempted to define the intentional learning (Bereiter and Scardamalia 1989; Subagdja, Sonenberg, and Rahwan 2009). One of the recent definitions was proposed by Lee, Rooney, and Parada (2014: 2) and stated that "intentional learning occurs when a learner wants to learn, sees the need to learn, believes in the need to learn, knows what to learn, knows what is needed to learn and knows how to learn." Intentional learning through digital media can occur in several different ways to learn English language whether they are educational or non- educational methods. Therefore, there would be a connection between intentional learning and the implementation of digital media, especially in a context where students are highly engaged with technology and digital media like the Saudi EFL one.

Digital media can be used for English language learning within two social areas, at school and outside of school (Gee 2004). The widest area of English language learning takes place in the outer and larger social context; outside of school when students intentionally use digital media for learning, because of the variety of content, as well as the various tools used. Various research studies (Al-Jarf 2014; Al-shehri 2012; Lu 2008; Jarvis 2013) investigated the use of digital media technology in EFL learning context and reported significant results.

3. RESEARCH METHODS

The overarching aim of this study is to understand the use of technologies for fostering EFL learning in the Saudi context. To achieve this aim, three concrete purposes are crafted to support it. First is to explore what kind of digital media technologies Saudi EFL high school students are using for English language learning. Second, is to identify how the most frequent digital media is used among Saudi EFL high school students to intentionally learn the four main skills of English language (i.e. reading, writing, speaking, and listening) outside school. The third aim is to examine the processes that underlie how Saudi students intentionally use digital resources to acquire specific (i.e. reading, writing, speaking, listening) English language skills. These aims will be guided by the following research questions:

1. How are Saudi EFL students using digital media to intentionally learn the four main skills of English language (i.e. reading, writing, speaking, and listening) outside the school context?
2. What are the strategies students used to intentionally learn English using the most preferred types of digital media outside the school context?
3. What are the factors that influence the choice of identified digital media in learning English outside the school context?

These Research Questions will be answered through a cross-sectional mixed-method study that will be conducted on a cohort group of year 12 Saudi EFL students. There will be three phases in this study. In the first phase, quantitative data will be collected through a questionnaire that will investigate the prevalent use of digital media technology and how Saudi EFL students intentionally learn English outside of the school. This questionnaire has some Likert-scale questions and open-ended ones. The participants in this questionnaire will be Year 12 Saudi EFL male students from 20 high schools, with 10 schools located in metropolitan areas and 10 in rural areas. The anticipated sample size is between 300-400 students that will be chosen randomly. The questionnaire will be designed electronically in Survey Monkey and distributed during school time using school computer labs.

The qualitative part will be in the second and third phases. In the second phase, semi-structured focus-group interviews will be utilized as a complementary method to investigate participants' experiences and knowledge relating to their prevalent digital media practices in and out of school. These interviews will be guided through a semi-structured style that is unique and would be suitable for this study; this type of interviews gives the researcher "some latitude to ask further questions in response to what are seen as significant replies" (Bryman 2008: 196). These interviews will be audio-recorded with the consent of the participants and their parents for those who are under the age of 18. The final third phase will be an online journal through which students will provide their insights and practical experiences in using digital media technology within four weeks. In this online journal, students will be asked to use their digital media technologies in the sake of learning English language outside of the school. Then they will be asked to describe their experiences by briefly answer three main questions. These questions will ask the participants about what types of digital media they have been using, what they are using that type for, and what they have learned by using that type. The participants in these two phases will be chosen from the questionnaire's participants and invited to participate.

The collected quantitative and qualitative data will be carefully analysed to achieve the study aims and answer the research questions. It is anticipated that this study will provide valuable data to guide the implementation of policies to support and foster intentional English language learning in the Saudi context. It is also expected that this study will contribute to the development of alternative language learning environments which environment that stimulate English language learning among Saudi EFL learners. Moreover, it is envisaged that the study will provide convincing evidence to support the implement of useful ideas and new materials into the Saudi curriculum and teaching policies to benefit from the booming technologies in the Saudi EFL context.

4. CONCLUSION

It is anticipated that this study will provide valuable data to guide the implementation of policies to support and enhance English language learning in the Saudi context. It is also expected that this study will contribute to the development of alternative language learning environments which environment that stimulate English language learning among Saudi EFL learners. Moreover, it is envisaged that the study will provide convincing evidence to support the implement of useful ideas and new materials into the Saudi curriculum and teaching policies to benefit from the booming technologies in the Saudi EFL context.

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CLOUD COMPUTING IN HIGHER EDUCATION SECTOR FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

Cloud computing is considered a new frontier in the field of computing, as this technology comprises three major entities namely: software, hardware and network. The collective nature of all these entities is known as the Cloud. This research aims to examine the impacts of various aspects namely: cloud computing, sustainability, performance management, government and other aspects in line to develop a new sustainable cloud computing model for the higher education sector in China. Currently, there are several obstacles facing the adoption of cloud computing in China, namely: lack of standards; insufficient educational data and disregard for environmental impacts. A mixed method approach will be employed in this research comprising at least 20 interviews to elicit the attitudes of the cloud users towards the initial model, based on the interviews feedback, the model will be optimized and an online survey will be conducted with a sample size of minimum 390 to examine the perceptions and attitudes of participants towards the new model. The main target participants will be students, academic staff and personnel working in IT departments in Chinese universities.

KEYWORDS

Cloud Computing, Sustainability, Model, China

1. INTRODUCTION

The concept of cloud computing was jointly proposed by Google and IBM in 2007 (Wang and Xing, 2011). Cloud computing is a computing platform that resides in a large data centre and is able to dynamically provide servers with the ability to address a wide range of needs, from scientific research to e-commerce (Jaeger et al., 2008). The global cloud computing market is expected to grow from US$40 billion in 2011 to US$241 billion in 2020 (Ried and Kisker 2011, quoted in Cheng et al., 2016). The development of cloud computing is growing rapidly and the cloud computing industry has great market potential in China (Yu et al., 2016). This research aims to examine the current cloud computing models, with the purpose of developing and evaluating a new cloud computing model for the higher education sector in China. An in-depth analysis of cloud computing will be conducted with respect to cloud computing, sustainability, performance management, government and other aspects in order to develop appropriate solutions for China.

2. UNDERSTANDING CLOUD COMPUTING

Cloud computing generally refers to an Internet-based computing model that various PCs and servers are associated with Internet, operating systems, software and database. These resources can be shared by multiple clients based upon their demands (Chi and Gao, 2011). Similarly, Vouk (2008) claims that cloud computing aims to maximize the profit and minimize the cost of computing by migrating software, hardware, operating systems and other computing service-related devices from local data centres to cloud servers provided by cloud venders, thereby enabling cloud clients to utilize the computing resources which are available in the cloud servers via client program at any time from any location where there is access to the Internet.

2.1 Service Models

According to Metz (2011), three cloud computing service models have been defined by NIST (National Institute of Standards and Technology): Software as a Service (SaaS); Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). Software as a Service enables cloud software or applications to be operated on the cloud-based virtual server, so the clients can access the resources at anytime from anywhere once they have linked to the network (Cusumano, 2010, Armbrust et al., 2010). Google Mail and Google Calendar are good examples of SaaS. Platform as a Service is the second cloud server model. Applications and services can be built in the cloud based on clients' requirements, so the cloud users can access the online applications without having to download or install them (Qayyum et al., 2011).Google App Engine is one example of PaaS. The third cloud server model is Infrastructure as a Service. The IaaS platform provider supplies the hardware, storage space servers and other computing devices to cloud clients. The platform can be utilized immediately which saves a lot of time for clients, and routine equipment maintenance is carried out by providers (Bhardwaj et al., 2010).

2.2 Deployment Models

Just as cloud services have different models such as SaaS, PaaS and IaaS, there are different deployment models of cloud computing as well. According to Metz (2011), four different deployment models for cloud computing have been outlined by NIST: Private cloud, Public cloud, Hybrid cloud, and Community cloud. Private cloud is defined as an individual institution operating its own cloud (Metz, 2011). According to Wyld (2010), in the private cloud method, the cloud infrastructure is owned solely by a company and it may be managed by the organization or a third party and may exist on the premises or off-premises. Schubert et al. (2010) point out that private clouds are normally operated by the respective organization; the functionalities are not exposed to the customers directly and it is similar to Software as a Service from the customer‘s perspective. A public cloud service is used by the general public(Metz, 2011). The cloud infrastructure can be accessed by the public cloud users or a large scale industry group and is owned by the cloud provider (Wyld, 2010). Public cloud is based on the standard cloud computing model and the cloud service provider will make resources such as storage space or applications available to the general public cloud computing users through the Internet. The subscription models of public cloud services include a pay-per-usage model or may even be free. Hybrid cloud allows institutions to deploy an application or system using more than one type of deployment model (Metz, 2011). Finally, the term "private cloud" refers to a proprietary network or data centre managed by the organization; "public cloud" means that public cloud users can share the cloud infrastructure; the hybrid cloud is maintained by both internal and external providers. According to VMware (Chang et al., 2010), hybrid cloud is a cloud infrastructure consisting of two or more clouds; private and public cloud can be combined together under standardized technology and specific rules that enable application and data portability. "The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise" (CISCO 2012). Schubert et al. (2010) believe that generally cloud systems are restricted to the local infrastructure; for instance, public cloud service providers offer their own computing infrastructure to users.

2.3 Current Status of Cloud Computing Development in China

According to the research report from BAS Global Cloud Computing Scorecard, China has shown enthusiasm for ICT development and improvement compared with other countries, and China was ranked in 19th among 24 countries that account for 80% of the global ICT market in 2013. Moreover, China has made critical progress regarding broadband coverage, and in June 2012 carried out a magnificent national broadband arrangement to meet the anticipated 800 million web clients in China in 2015 (2013). As for the education area, believe that there is an immense shortfall in educational information among different districts, between urban and rural areas and among various schools (Wang and Xing, 2011, Wang, 2002, Mundial, 2013). Because of the dense population and vast territory of China, some areas of public education, assets allocation and utilization are not adequately supervised.

2.4 Research Gap

Governance involves the strategic task of establishing an organisation's goals, direction, limitations and accountability frameworks. It is necessary to set up the governance strategy up front if universities or institutions consider adopting the cloud computing technology. Once cloud computing has been adopted, performance management is required to ensure that the system operates as planned. Moreover, sustainable green IT attracts more attention nowadays. Environmental sustainability has been defined as "development that meets the needs and aspirations of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Thus, governance, sustainability and performance management should be considered together when developing a cloud computing model. To the best of my knowledge, none of the articles which have been reviewed so far has covered these three aspects together, so this study aims to create a cloud computing model that includes cloud computing governance, sustainability and performance management.

3. RESEARCH METHOD AND QUESTION

The mixed methods approach has been chosen for this research. Mixed methods research is a methodology for conducting research that involves collecting, analysing, and integrating quantitative and qualitative research in a single study or a longitudinal program of inquiry. The advantage of this form of research is that both qualitative and quantitative research, in combination, provides a better understanding of a research problem or issue than either research approach alone. This research contains online survey and semi-structured interviews. In this research, all the data will serve to resolve the research questions, and the online survey will contain both close-ended and open-ended questions. Thirty universities from top 500 universities in China have been selected as the target participants of this research, and data of interviews and questionnaires will be mainly gathered from these 30 universities. This research aims to develop and evaluate a new cloud computing model for the higher education sector (universities) in China, and would answer the following question: What are the perceptions and attitudes of students, academic staff and IT department personnel towards the new sustainable cloud computing model in Chinese universities? Certainly target participants would have different expectations as their needs are different, various information would be received from participants, thus software like Nvivo will be utilised with the purpose of analysing and combining the useful information to develop a sustainable cloud computing model for Chinese universities.

4. RESEARCH OUTCOME

This research will provide a detailed description and new perspective on the cloud computing in Chinese universities. Based on the literature review, an initial model was developed and it consists of three components namely: governance, sustainability and performance management. The proposed model aims to provide a broader view of the cloud technology by combining all these three elements together. Internal stakeholders such as students' staff and IT personnel will be the users of the new model, and external stakeholders' service provider, researchers, software developers, government, research partners, etc. could also be effected by this model. This research will review the current cloud computing models. A series of solutions and standards regarding cloud computing will be generated in this research. The outcome of this research is a new cloud computing model which can be applied to universities in China in the future. It is anticipated that this model will encourage Chinese universities to adopt the cloud computing technology in line to become more sustainable. For those universities who already using the cloud technology, this model will provide some valuable information to improve their cloud strategy. Furthermore, with certain modifications, this cloud model could be adapted for other universities in other countries. The new model will be evaluated by using mixed methods approach. The new cloud computing model will be developed to support a great number of potential cloud users who need to clearly understand the principles for cloud-related governance; enterprise architects, business analysts and software developers who are willing to adopt newer approaches to develop and deploy cloud services and infrastructures based on a new cloud computing model; cloud computing field researchers who would like to further increase their understanding of the governance, sustainability and performance management aspects of cloud computing; and students and lecturers who are interested in further enhancing their cloud-related knowledge.

5. CONCLUSION

In conclusion, this research provides an initial description regarding the cloud computing model for the Chinese universities. The proposed model aims to improve the environmental sustainability and efficiency of the use of resources in China, especially in the higher education sector. Also, this research will review the current cloud computing models. A series of solutions and standards regarding cloud computing will be generated. The research outcome will benefit potential cloud computing users and institutions in China and globally simultaneously. As time limited, only a few aspects and components from cloud computing have been examined to form this new model in this paper, however, further discussion will be carried out in the future to discuss the assessment, examination and feedback from stakeholders.

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EXPLORING CONNECTIVISM IN THE CONTEXT OF ONLINE SOCIAL TRADING

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ABSTRACT

The main goal of this paper is to explore connectivism for understanding online social trading. The basic concept behind it is that performance indicators from experienced traders can influence others who are not experienced to follow and copy their investment behavior in a digital platform. The theoretical discussion from this reflection paper could inform future research and practice on how online social trading operates. The discussion can question the short term speculative effect of leading traders and their followers, contrasting this to a long term relationship-building approach. Reflections from this discussion could inform a more in-depth study on the subject using empirical evidence.[i]

KEYWORDS

Social Trading; Connectivism; Investing; Online Platforms

[i] Note: It is the authors' choice not to hand over copyright for publishing the complete paper in the proceedings.

Posters

A PRELIMINARY INVESTIGATION INTO THE INFORMATION SHARING BEHAVIOR OF SOCIAL MEDIA USERS AFTER A NATURAL DISASTER

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ABSTRACT

The paper provides the results of a preliminary investigation into the information sharing behavior of social media users after a natural disaster. The results indicate that users shared information that they thought victims would find useful. On the other hand, they reported that they usually do not or never share information considered useful to others. The results suggest that users' behavior in emergency situations differs from that in everyday situations. It is necessary to investigate this behavior in detail.

KEYWORDS

Social Media Site, Information Sharing, Users' Behavior, Emergency Situation

1. INTRODUCTION

The diffusion of social media, including social networking sites (SNSs), Twitter, and blogs has been remarkable. Clearly, these sites have permeated our daily lives. As social media usage with mobile devices such as smartphones and tablet devices increases, it has gained attention as a way to communicate in emergency situations such as natural disasters. Moreover, many researchers consider social media as promising tools for gathering information to learn about the state of the disaster site and victims' requirements. This is attributed to social media characteristics such as the immediate and extensive dissemination of information. Therefore, various studies continue, for example, those that analyze posts on microblogging sites after major disasters (Vieweg et al. 2010, Qu et al. 2011) or that develop applications for utilizing Twitter (Uchida et al. 2015).

Another characteristic of social media is to share information via social feedback such as through retweeting and pressing the like button (liking) easily. When users who view original posts share this information with others not connected to the original user, the posts are immediately and widely disseminated. However, sharing information is not always useful in emergency situations. Sharing incorrect or inappropriate information interferes with the distribution of useful information regarding responses to emergency situations. To utilize social media, it is important to explore the information sharing behavior of users in detail.

This study aims to reveal user behavior and intention to share information on social media. This presentation provides the results of a preliminary investigation conducted after a major earthquake in Japan.

2. INVESTIGATION

The survey for this study was conducted to reveal users' behavior and intention to share information related to a natural disaster. Specifically, information sharing behavior related to the 2016 Kumamoto Earthquake, which occurred in April 2016 in the Kyushu region in Japan, was targeted in this survey. The survey was conducted in July 2016, about three months after the earthquake.

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University students in Japan were invited to participate after being provided with information about the goal of the study and informed of the voluntary and confidential nature of participation. Participants were not victims of the earthquake. A total of 135 university students enrolled in computer classes completed the questionnaire. Of these, 106 respondents reported that they were SNS users (including Twitter users), and these individuals became the main subjects of this analysis.

The online questionnaire included four parts: 1) questions about demographics and SNS usage, 2) questions about behavior regarding sharing information related to the earthquake, 3) questions about behavior regarding sharing information in everyday situations, and 4) questions about the intentions of SNS usage. Part two comprised five sections. In the first and second sections, 16 types of information related to the earthquake (Table 1) were listed. Participants were asked to respond if they viewed and shared each type of information. The third section contained 25 items asking about the reasons to share information related to the earthquake. The fourth section contained 22 items asking about reasons information was not shared. The fifth section asked about what type of information they shared in everyday situation. In the third and fourth sections, participants were asked to report the degree of their intention to share or not to share information corresponding with the reasons mentioned in each item. Responses were provided on a four-point Likert scale (from “1: corresponds” to “4: does not correspond”).

3. RESULTS AND DISCUSSION

A large number of participants responded that they viewed news or information related to the earthquake on social media, for example, information related to seismic intensity, the epicenter, and damage caused by the earthquake. More than 80% of participants responded that they viewed each type of information. A relatively small number of participants responded that they viewed information pertaining to “post requesting rescue by victims themselves” (38.7%) and “posts confirming someone’s safety” (49.1%). For other types of information, approximately 50% to 70% of participants reported that they viewed each types of information. It is feasible that many users were interested in the earthquake and viewed information pertaining to it. For 16 types of information, the percentages of those sharing information (e.g., by retweeting or liking) for those viewing them were calculated. The average of percentages of sharing information is 18.0%. A relatively small number of participants reported sharing each type of information. The percentage is 24.4% for “post requesting rescue by victims themselves.” The second highest is 24.1% for “post requesting assistance by victims themselves.” The ratio of sharing “information relating the earthquake itself (seismic intensity, epicenter, etc)” is 23.3%. It seems that information with the potential to help victims was widely shared. Regarding the reasons to share information, a relatively large number of participants responded that their intentions to share information corresponded with the statement that “I thought the information would be useful to others.”

For questions related to everyday sharing behavior, more than half the participants reported often sharing or sharing information such as “information that interests you,” “information with content you can sympathize with,” “information that makes an impression,” and “information you felt was interesting.” On the other hand, more than half the participants reported that they do not or never share “information others may find beneficial.” However, the questionnaire results indicate that participants tended to share information useful to others in emergency situations. This suggests that information sharing behavior in an emergency situation differs from that in everyday situations. It is necessary to investigate this behavior in detail.

4. CONCLUSION

A survey was conducted to reveal social media users’ behavior and intention to share information related to a natural disaster in an emergency situation. The results indicate that users shared information they thought would be useful to victims. On the other hand, they reported that they usually do not or never share information considered useful to others. These results suggest that users’ behavior in emergency situations differs from that in everyday situations. It is necessary to investigate this behavior in detail.

Table 1. The number of participants who responded they viewed or shared news or information related to the earthquake

	Viewed	Shared	Percentages*
(1) Information relating to the earthquake itself (seismic intensity, epicenter, etc.)	90	21	23.3
(2) Information relating to earthquake damage	90	18	20.0
(3) Posts requesting rescue by victims themselves	41	10	24.4
(4) Posts requesting assistance by victims themselves	58	14	24.1
(5) Posts requesting rescue by people other than victims	66	13	19.7
(6) Posts requesting assistance by people other than victims	73	15	20.5
(7) Post confirming someone's safety	52	8	15.4
(8) Posts reporting about someone's safety	54	11	20.4
(9) News relating to earthquake damage	89	17	19.1
(10) News relating to the earthquakes	91	17	18.7
(11) Assistance information directed at victims	78	11	14.1
(12) Requests for volunteers	54	8	14.8
(13) Posts relating to the volunteer situation	59	8	13.6
(14) Posts sharing personal experiences and impressions relating to the earthquake by victims themselves	58	9	15.5
(15) Rumors relating to damage from the earthquake	68	8	11.8
(16) Posts sharing impressions about the earthquake by people other than victims	67	8	11.9

* the percentages of those sharing information (e.g., by retweeting or liking) for those viewing them

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EFFECTS OF A TECHNOLOGY-FRIENDLY EDUCATION PROGRAM ON PRE-SERVICE TEACHERS' PERCEPTIONS AND LEARNING STYLES

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ABSTRACT

A technology-friendly teacher education program can make pre-service teachers more comfortable with using technology from laggard to innovator and change their learning styles in which they prefer the use of technology in teaching. It is investigated how a technology-friendly mathematics education program, which provided 49 pre-service teachers an opportunity to conduct technology-based class activities and to develop teaching materials using technology, affects their perceptions about technology and learning styles. Results showed that participants were more highly receptive to be an innovator or early adopter which means they are more eager for using technology as a teaching tool. This implies that teachers' perceptions and learning styles can be potential, sustainable, and possible variables to be changed for meaningful teaching with technology.

KEYWORDS

Technology-friendly education program, perception, learning style

1. INTRODUCTION

Technology as a tool can support instruction to help students see concrete characteristics through visualizing abstract mathematical concepts and explore conceptual properties through directly manipulating those concepts by themselves. In addition, visualization through technology can improve students' motivation, engagement, and thus development of mathematical thinking when they appropriately use it. These advantages in the use of technology for learning mathematics have been emphasized in developing a curriculum (NCTM, 2000). Although many advantages of using technology in curricula have been advocated by researchers, teachers still have negative perspectives on using technology in their classes because of a lack of knowledge and experience. In order to help teachers overcome their negative perspectives on technology and encourage them to use it in their classrooms, a technology-based education program, which can raise the possibility of not only changing their perceptions about technology, but also preferring their learning styles to employ technology in teaching, is a viable, interesting, and sustainable option to be conducted during the period in pre-service teacher education. A technology-friendly teacher education program can make pre-service teachers more comfortable with using technology from laggard to innovator and change their learning styles in which they prefer the use of technology in teaching (Kim, 2015). As a result, these two changes can increase the sustainable probability of technology use into their future classes.

For this purpose, 49 pre-service teachers in a university in Seoul, Korea participated in the study. It is investigated how a technology-friendly mathematics education program, which provided them an opportunity to conduct technology-based class activities and to develop teaching materials using technology, affects their perceptions about technology and learning styles. Results showed that participants were more highly receptive to be an innovator or early adopter which means they are more eager for using technology as a teaching tool because they changed their Technological Pedagogical Content Knowledge (TPCK) in planning a technology-based class to motivate students and help them to understanding mathematical concepts according to the post-survey results (Kim et al., 2013). Thus it can be inferred that the pre-service teachers would be more likely to use technology in their future classrooms. Second, the participants who experienced the program changed their learning styles whose elements consist of visual mode because there was a statistically significant difference in student reflections for the usefulness of technology-based learning between the pre-survey and post-survey.

Table 1. Results for changes in learning styles (Note: *p < .05)

	Contents	Pre-survey M (SD)	Post-survey M (SD)	df.	t	Sig. (2-tailed)
Visual type	Oral guidance notes are much easier to follow than written guidance notes.	0.49 (0.87)	0.43 (0.91)	48	0.417	0.679
	For review, I prefer to write down or make a note.	0.73 (1.19)	0.86 (1.10)	48	-0.747	0.459
	I love to develop and make either a graph or a chart and do it well.	-0.04 (0.94)	0.35 (0.86)	48	-2.571	0.013*
	I can easily understand and follow directions in a map.	0.84 (0.72)	1.08 (0.64)	47	-2.372	0.022*
	I can understand news better by reading rather than listening to it from radio.	0.43 (1.0)	0.33 (1.11)	48	0.598	0.553
	The best way to memorize something is to visualize its picture in my mind.	0.82 (0.83)	1.02 (0.85)	48	-1.808	0.077
	I love to touch something by my hand during learning.	0.43 (0.91)	0.86 (0.89)	48	-3.000	0.004*
	I get information in the field of interesting subjects by reading related resources.	0.82 (0.73)	0.90 (0.82)	48	-0.703	0.485
Auditory type	I can memorize a topic better by listening rather than reading.	-0.16 (0.72)	-0.04 (0.84)	48	-0.903	0.371
	I need explanations about graphs, diagrams, and visual directions.	0.59 (0.79)	0.49 (0.89)	48	0.843	0.404
	When hearing two voices, I can tell the difference between them.	0.69 (0.74)	0.86 (0.71)	48	-1.938	0.059
	I can do better in a course work by having a lecture or listening to a tape.	0.47 (0.98)	0.69 (0.71)	48	-1.710	0.094
	I can memorize a word better by repeatedly speaking rather than writing it in a paper.	0.20 (0.93)	0.37 (0.95)	48	-1.273	0.209
	I love more to listen to a lecture or a speech than to read it.	0.41 (0.96)	0.53 (0.89)	48	-0.948	0.348
	I prefer to listen to news from radio rather than reading the news in a newspaper.	-0.10 (0.80)	-0.02 (0.97)	48	-0.531	0.598
	Verbal directions are much easier to follow than written directions.	-0.04 (0.84)	-0.02 (0.83)	48	-0.136	0.892

After pre-service teachers experienced the program, they preferred to develop and make visual teaching materials such as graphs and charts and to use touching and visualizing activities in learning. They perceived that the use of technology environments and activities is very effective for them to increase their visualizing filters and seems to cultivate their confidence in technology use. In this process, activities for visualizing abstract concepts and properties help them engage more frequently in visualizing processes and thus assist to change in the degree of their visual learning styles.

Based on a technology-friendly education program to be implemented, this study has provided insight into the views of teachers' perceptions and learning styles as key issues for them to create potential and sustainable opportunities for meaningful teaching with technology. One implication for teaching practice is that providing a technology-friendly learning environment to per-service teachers may help them become more comfortable with using technology in their classes over the length of time. As they become more comfortable with using technology in their classes and change their receptivity to and their beliefs about the use of new technology, in the long run, they would be more likely to employ the sustainable use of technology for pedagogical purposes in their future classes.

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USE OF COGNITIVE AND METACOGNITIVE STRATEGIES IN ONLINE SEARCH: AN EYE-TRACKING STUDY

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ABSTRACT

This study used eye-tracking technology to track students' eye movements while searching information on the web. The research question guiding this study was "Do students with different search performance levels have different visual attention distributions while searching information online? If yes, what are the patterns for high and low performing searchers?" 14 university students in Macau were invited to search an answer online for the question: "After you clean a glass with tap water, why are there always some water drops remaining in the glass surface?" A Tobii Pro X2-30 remote eye tracker was used for data collection. Two students with the highest and lowest search task scores were selected for comparisons in their online search behavior and eye-movement patterns. The high-performing student worked more in revising search queries, and reading and assessing the information in the selected webpages for its relevance. Search patterns showed that the high-performing student tended to switch more frequently between search query box and search result page whereas the low-performing student tended to switch between the search result and selected web page. This implied that the high-performing student was more metacognitively engaged by revisiting and revising search queries to improve the quality of search results.

KEYWORDS

Web search; (meta)cognitive strategies; eye-tracking

1. INTRODUCTION

Eye-tracking measures can reveal individuals' cognitive processes, especially attention distributions which reflected the use of cognitive and metacognitive strategies to some degree (Lai et al., 2013), for example, in equation solving (Susac et al., 2014) and translation tasks (Angelone, 2010). To date, insufficient effort has been made to investigate how individuals allocate their attention and use (meta)cognitive strategies to search information online, although the research on web search has grown vastly in the past decade. For this purpose, this study used eye-tracking technology to track and observe students' eye movements while searching information on the web. The research question guiding this study was "Do students with different search performance levels have different visual attention distributions while searching information online? If yes, what are the patterns for high and low performing searchers?"

2. REVELANT WORK

Eye-tracking methodologies seem particularly promising in online search because gaze can be used as a proxy for a user's attention (Cutrell & Guan, 2007). Ocular indices by eye-tracking techniques enable us to determine what information a user is indeed viewing and reading, for how long, and in what order. The moment-by-moment observations by eye-tracking provide more details about how users interact with information online than other measures such as mouse clicks, query streams or web logs (Cutrell & Guan, 2007). Efforts have been made in the past years in examining how individuals search, process and assess information online by eye-tracking. For example, Joachims et al. (2005) used eye-tracking techniques to

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characterize how users peruse search results; Pan et al. (2004) investigated the factors that affected web page viewing behavior during search; Gerjets, Kammerer, and Werne (2011) examined how individuals evaluated search results.

The above studies provided important insights in understanding how individuals search for information on the Web, yet they tended to investigate this process in specific stages, e.g., browsing results, assessing and selecting results and etc. The research presented here seeks to obtain a more comprehensive understanding of whether and how the searcher regulates the search process as a whole and what cognitive and metacognitive strategies were applied to reach their goal.

3. METHOD

A group of 14 students from different departments in a public university in Macau (50% females, mean age was 23 years old) were invited to a computer station to search an answer online for the question: "After you clean a glass with tap water, why are there always some water drops remaining in the glass surface?" All participants used IE as the web browser. The students were allowed to finish the task in their own paces. Each answer was scored by two research assistants based on the completeness and accuracy of the answer. A Tobii Pro X2-30 remote eye tracker was used for data collection.

Several indices were used as indicators of ocular behaviors. Eye fixations are defined as a spatially stable gaze lasting for approximately 200-300 milliseconds, which represents the instances in which information acquisition and processing is able to occur (Rayner, 1998). Scanpaths were used to reveal eye-movement patterns which connected saccades and fixations. They depicted a complete sequence of fixations and saccades within different areas of interest (AOIs). We defined three AOIs for each screen within each task and participant: the search box area, search result page and selected webpage. For each AOI, we computed eye fixation duration and frequency count.

4. RESULTS AND DSICUSSION

Two students with the highest (full score) and lowest scores (zero score) were selected respectively for conducting comparisons in terms of their online search behavior and eye-movement patterns. As shown in Table 1, the high-performing student gazed for a significantly longer time, with a much higher frequency in the search box and selected webpages than the low-performing student. The heatmaps in these two AOIs revealed that the high-performing student did not spend much more time in scanning the result page, but working more in revising search queries and reading and assessing the information in the selected webpages for its relevance to the search problem. This revealed the more effective use of cognitive strategies in high-performing searchers: significantly more time allocated to search query construction and information evaluation. These two stages in web search seem to present higher chances for search success.

Table 1. Total eye fixation duration and total eye fixation count for low and high-performing students

	Total Eye Fixation Duration(s)			**Total Eye Fixation Count**		
	search box	result page	selected webpage	search box	result page	selected webpage
Low	80.9	13.35	131.3	342	34	557
High	165.3	16.15	483.8	723	55	2195

Subsequent search behavioral patterns in these two participants showed clear differences in the process of online search. The high-performing student tended to switch more frequently between search query box and search result page whereas the low-performing student tended to switch between the search result and selected web page (see Figure 1). This suggests that the high-performing student was more metacognitively engaged by revisiting and revising search queries to improve the quality of search results and thus search outcomes than the low-performing student.

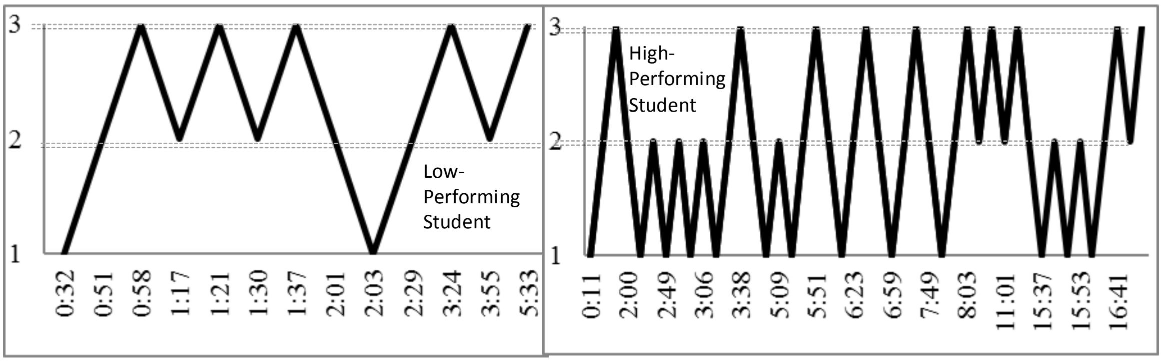

Figure 1. Search behavioural patterns for low and high-performing students. 1 = Construct and revise search queries; 2 = Scan and evaluate search results; 3 = Select a result and access the webpage

5. CONCLUSION

We presented a study using eye tracking techniques to investigate online search strategies. We believe this study is only a prelude to examine this issue from a metacognitive perspective. It would be interesting to replicate this study with a larger and more diverse sample to verify the patterns we located here. In such way, we can further provide suggestions or design interventions to help searchers to improve their online information search performance.

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DEVELOPMENT OF A DIAGNOSTIC SYSTEM FOR INFORMATION ETHICS EDUCATION

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ABSTRACT

This paper presents a new diagnostic system for information ethics education. In order to educate children about information ethics, it is necessary to know the stage at which they currently are in terms of their knowledge of the same. Some actual condition surveys have been conducted by the Cabinet Office and the National Police Agency to gauge the extent of this knowledge; however, such large-scale actual condition surveys are unable to reflect the true extent for each school. But if teachers were to conduct these surveys in their schools themselves, it would be an added burden for them since they already have immense workload.

We have developed, tested, and evaluated an easy-to-use system that can enable teachers to ascertain the level of education in information ethics among children at their school.

KEYWORDS

Information ethics education, Actual condition, Diagnostic system, Evaluation

1. INTRODUCTION

These days, many young people tend to cause as well as get into trouble over the Internet. Consequently, the Central Education Council Report (2008) declared that information ethics education must be imparted in every school.

In order to educate children about information ethics, it is necessary to know the stage at which they currently are in terms of their knowledge of the same. Some actual condition surveys have been carried out by the Cabinet Office and the National Police Agency to gauge the extent of this knowledge. Nevertheless, such large-scale actual condition surveys do not necessarily reflect the true extent of awareness among children at each school. This is problematic because if teachers were to conduct their own surveys, it would be an added burden for them since they already have immense workload.

In order to address this problem, we have developed a new diagnostic system for information ethics education. We have tested and evaluated it as well. It has the potential to enable teachers to easily determine the level of awareness of information ethics among children at their school.

This system is guided by the "5 strands of information ethics education" as suggested by the Ministry of Education. These are: ethics in information society, understanding and complying with the law, wisdom for security, information security, and constructing a public network society. The main purpose is to assess children's knowledge of information ethics and to evaluate the extent of Internet usage. For this, children are made to electronically answer a set of questions over the Internet. This can be done by the students using their own tablets or the schools' computer facilities. The system, then, immediately sends these results to their teachers who can study these and accordingly plan their lessons.

In total, there are 25 questions with four possible answers to choose from. These include seven questions about how frequently children use the Internet and six additional questions on morality, security, and law. The questions on frequency of usage entail a total of 10 points and the rest a total of 30 points. (See Figure 1).

Figure 1. A screenshot of the questionnaire

2. DEVELOPMENT

Teachers receive three types of feedback from the children's answers on the diagnostic system. These are the following:

1. A count of the number of questions answered correctly by the child.
2. A comparison of the students' responses from the teachers' own class with those of the students from other classes, across grades, as well as in comparison to the national average. (See Figure 2)
3. Identification of the children who require being educated about information ethics. (See Figure 3)

The system also marks the scores of the children's knowledge of information ethics and the status of internet usage by them in order to enable teachers to support their needs as smoothly as possible.

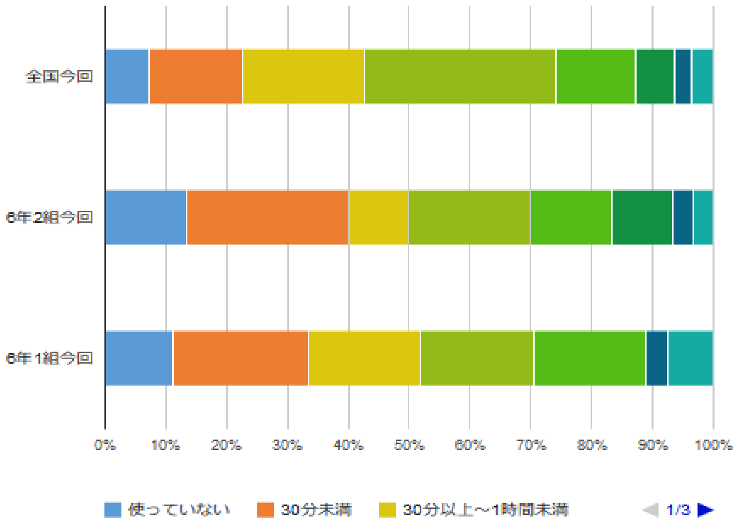

Figure 2. A screenshot of the results of the actual condition (Comparison)

Description of Figure 3:
Vertical axis: status of Internet usage. (Filtering, rules, usage etc.)
Horizontal axis: the responses from the questionnaire.
Children in the third quadrant of the figure need to be supported.

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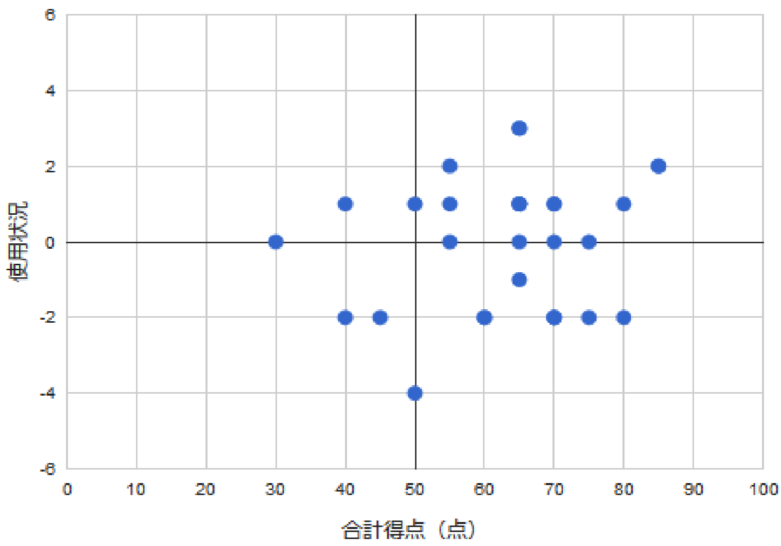

Figure 3. Screenshot of Distribution

3. TEST AND EVALUATION

We tested the diagnostic system with 60 students from the sixth grade and 29 from the eighth grade.

The results show that the eighth graders scored higher points in "Knowledge" of information ethics than the sixth grade. That made it sure that the evaluation in "Knowledge" was adequate. (See Table 1)

Table 1. School type score of each category (SD)

	Total	Net Morality	Security	Low	Situation
Elementary School	62.54 (13.35)	22.28 (5.22)	20.96 (7.10)	13.86 (6.28)	5.43 (3.28)
Junior High School	68.62 (10.98)	25.34 (4.72)	22.76 (5.66)	14.66 (5.56)	5.86 (3.72)

In addition, we also interviewed the teachers of these students. They found value in receiving information about the level of awareness among the children of their class.

We are working on further improving the system by increasing the numbers of trials, evaluating them more precisely, interviewing teachers etc.

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A PRACTICAL STUDY OF MATHEMATICS EDUCATION USING GAMIFICATION

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ABSTRACT

This paper explores the use of gamification in math lessons for children in order to highlight the relationship between math education and its application to society. In school education, there is an existing problem about how to relate concepts learned in math to everyday life. One of the reasons for this problem is that it is difficult for teachers to set appropriate questions for students.
We investigated a classroom using gamification intended for elementary school sixth grade students (34 people). As a result, it is argued that gamification is effective in math education.

KEYWORDS

Gamification, Elementary school students, Math class

1. INTRODUCTION

In school education, there is an existing problem about how to relate concepts learned in math to situations in everyday life. One of the reasons is that it is difficult for teachers to set appropriate questions to students learning math. For example, when the teacher asks a math question, students do not think about it in relation to society. Therefore, this study considers the use of gamification to solve this problem. Gamification is the application of aspects such as "scenarios" and "competition" from a technological game-playing context to a non-gaming situation (in this case, the context of a classroom). A performance evaluation was conducted using gamification. First, teachers made a realistic scenario using videos and photos related to the math lesson.; second, children competed with each other in the same scenario. This study highlights and verifies the effectiveness of the gamification method that was used for children learning math.

2. METHOD

We think that there are two advantages in using Gamification. One is the ability of children to feel the need to question. With a mathematical problem integrated into a scenario, children enact on this need. The second point is that scenarios considered "fun" improves children's motivation and interest for learning. We developed the lesson with these two points in mind.

The research was conducted in a classroom using gamification intended for an elementary school sixth grade class (34 students). The class was given a scenario in which children had to simulate staff members of the local football team (the team's name is "SHIMIZU S-Puls") were asked to develop goods related to a football game for the children. The children were set the task of not only designing the goods but also consider their material costs and sale prices. When we set this task, we added the illusion of reality by relaying it through a video message.

After the class, the children were evaluated based on their design and ideas using a rubric (See table 1).

Table 1. Rubric evaluation (The method for evaluation)

Evaluation item	A Group	B Group	C Group
Interest (Ingenuity of goods design)	A well designed devise	A fairly well designed devise	A not so well designed devise
Knowledge (using a proportional calculation)	Calculated correctly and carefully completed, possible to determine profit	It is possible to give an answer to the calculation	Has not been calculated until the end
Calculation (Appropriateness of the calculation)	Possible to be used efficiently, proportionally well calculated	Can be a reasonably efficient calculation	Calculation is not proportional
Representation or graph (Correctness of graph)	Expressed in an easy-to-understand proportionality graph	It is possible to write a graph of the proportionality	Unable to write a graph determining proportionality

3. RESULT

The results were evaluated using the above rubric. The number of Interest in column “A” was 30 people, while “B” stood at four. In the “Knowledge” criteria, “A” consisted of 21 students, while the number evaluated to level “B” was 12. Only one student was assessed at level C. In the evaluation of “Calculation,” five students achieved grade “A,” while 18 were assessed at “B,” with again only one at “C.” In the “Representation or graph” evaluation, level “A” was given to 10 students, “B” was awarded to 18, while “C” given to six people.

After the exercise was completed, a survey was distributed to the students which included two questions (See Table 2). As shown in Table 1, a significant difference was observed for each of the items before and after the lesson was conducted. As a result, it may be concluded that gamification is effective in math education.

Table 2. Questionnaire results (average value)

Question	Before class	After class	Significant difference
Do you think that “arithmetic” concepts are related to society?	2.91	3.49	**
Do you think “proportionality” is related to society?	2.52	3.21	**

4. CONCLUSIONS

From the results of this study, the gate for teaching and evaluation methods that incorporate the application of gamification concepts is open as children are more likely to feel the connection between the subject and society. It will also increase student motivation and interest.

On the other hand, If children have a difference of academic ability, Gamification might have no effect. Therefore, challenges remain in terms of measuring a child’s academic ability.

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DEMONSTRATING THE COLLATREX FRAMEWORK FOR COLLABORATIVE CONTEXT-AWARE MOBILE TRAINING AND EXPLORATION

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ABSTRACT

The CollaTrEx framework for collaborative context-aware mobile training and exploration is designed for the in-situ collaboration within groups of learners performing together diverse educational activities to explore their environment in a fun and intuitive way. It employs both absolute and relative spatio-temporal context for determining available activities and supports seamless collaboration in spite of temporary connection losses or when in remote areas. This demo showcases the prototype system and front-end implementation for tablet devices, inclusive of new activity types such as contour drawing, which aim at aiding memory retention to provide a more effective learning experience.

KEYWORDS

Location-based mobile learning, context-awareness, in-situ collaboration, tablet-based application prototype

1. MOTIVATION AND BACKGROUND

The proliferation of mobile devices equipped with a multitude of sensors as well as advanced recording and networking capabilities offers an enormous potential for educational applications. The advantages and opportunities of context-aware mobile learning are widely recognized (Sampson & Zervas 2013), but modern smartphones, tablets or wearables with their GPS antennas, magnetometers and gyroscopes, not only allow for establishing precise spatio-temporal context. Their multi-touch screens, high-resolution cameras and microphones, together with the support of various long- and short-range network protocols, call for increased interactivity and collaboration. However, instead of harnessing these capabilities to full effect for a genuinely collaborative and interactive mobile learning experience, they are often left unexploited.

The CollaTrEx framework (Botev et al. 2016) integrates the two paradigms of situated learning (Brown et al. 1989, Lave & Wenger 1991) and collaborative learning (Vygotsky 1978), thus combining context-aware, experiential and social factors. Its prime focus is on intra-group cooperative aspects, i.e., support for active in-situ collaboration within groups of learners exploring their environment. The diverse activities are designed to accommodate various age levels and content ranging from basic, e.g., for city guides or sightseeing, to academic, as for instance in the outdoor collaborative scenarios classified (Vasilou & Economides 2007). Single-user mobile learning scenarios as subclasses of the corresponding, collaborative cases are also inherently supported. To determine which activities are available and to provide a tailored experience both for leisure and academic settings, absolute and relative spatio-temporal context is employed. The framework also supports different on- and offline modes and buffering strategies since particularly in remote areas the necessary infrastructure or proximity between groups of learners cannot always be assumed.

2. DEMONSTRATION

In this demo, we present the CollaTrEx prototype system and the front-end implementation for tablet devices with the various available activities. Collaborative image capturing and particularly the novel contour drawing and detection serve as exemplars for how the active examination of a specific subject can support memory retention to help establish relevant knowledge providing an effective learning experience. Users are able to receive immediate feedback on their input which can be evaluated locally and independent of connectivity status.

Interested parties will be able to try out the application on one or several tablet devices to get a first-hand impression of the user interface philosophy and performance of the underlying technologies and algorithms.

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DEVELOPMENT OF TRAINING/SELF-RECOGNIZING TOOLS FOR DISABILITY STUDENTS USING A FACE EXPRESSION RECOGNITION SENSOR AND A SMART-WATCH

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ABSTRACT

In this paper, we developed two kinds of application software run on a mobile/wearable device for autistic spectrum disorder students, intellectual disability students, or physically challenged. One of the applications is expression detector/evaluator using a smartphone and a small expression sensor for social skill training. This sensor can inspect human's face-expression. We developed simple games with using it. Students can train to make his/her own expression by playing the game. The second of them is mental detector application using a heartbeat sensor in a smart watch. Using it, a students can predict own agitation by his/herself and the application informs it to a teacher. These two approach are desirable ICT application examples for the person. These can lead the students self-respecting, teachers mentioned.

KEYWORDS

Special need education, smart-phone, smart-watch, detecting expression, inspecting agitation, and by themselves

1. INTRODUCTION AND OUR WORKS

Japan government enforced the new law of reasonable consideration to any disorder/disability students in any education from April 2016. However, teachers who don't have enough experience in special needs education aren't able to grasp and infer such students' intention and feeling unfortunately. Moreover, students have the desire to use their bodies effectively. In particular, face expression is one of the important factors for communication with others. To respond to these issues, we developed two approaches.

The first approach is a face-expression training game for students using the expression-sensing sensor OMRON HVC-C (Human Vision Components C1B model) and a smartphone (Figure 1). This game is a kind of quiz game. A student answers questions by making face-expression e.g. smile, angry, sad, surprise and serious. This application is able to record data which corresponds to the duration of time and rate of correct answers. After training, the screen displays face-expressions in the same sequence. Appling this approach, a person who is not only physically challenged and but also has a panic disorder will be able to send a signal or control devices.

Figure 1. A face sensing sensor HVC-C (left) and a question mode screen on a smart-phone (right)

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The second approach is a self-recognition application using a smart-watch and a smartphone. The smart-watch is a watch-type wearable device that resembles a wristwatch. In this work, we use a smart-watch "Moto 360". Using it, we can measure the rate of heartbeats easily. According to the rate, this application can show meaningful messages on the screen of the smart-watch e.g. "You seem to be sad. Are you OK?", "Calm down" or "Breathe deeply" and so on. At the same time, the result is sent to a teachers' tablet PC who can then grasp the situation and take appropriate action.

Figure 2 shows a user wearing the smart-watch on the wrist and running the application. The application can indicate notices such as vibration, showing messages/images on the device's screen when the rate of heartbeat exceeds a particular value which was set in advance. When rate of the heartbeat falls, the reason is because it is thought that I am in a tense state during an angry time.

Figure 2. Wearing a smart-watch on the wrist

2. HOW TO USE OUR APPLICATION

Firstly, our developed face-expression training application uses a smartphone and the HVC-C. After the application is installed on the smartphone, connect the smartphone and the HVC-C. When both are connected, the screen of the smartphone turns into a question mode, that shows a situation and ask what type of expression a student makes at that time. If the student decided to make a face-expression, the application evaluates the face-expression by touching the smartphone screen. If the student can select the correct face-expression, the smartphone screen transitions to the next question mode (Figure3). During making face-expression, the smartphone records some data at that moment until the correct face-expression and name of face-expressions is selected. After training, a smartphone creates a data file that contains the duration of time, a name of face-expression and so on. To share the data files, people who want to know a result of training can see it with other devices e.g. smartphone, tablet and computer.

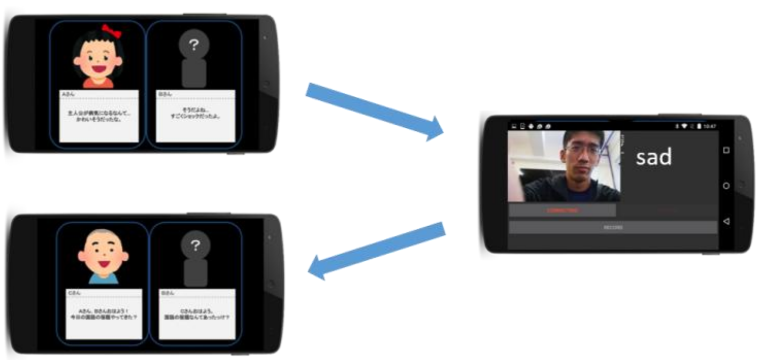

Figure 3. Transit screen on a smartphone

Secondly, we developed a self-recognition application. A person who wants to measure heartbeat rate wears the smart-watch on the wrist. To start the application on a smartphone, you need touch a button on the smart-watch application. It begins the measurement of the heartbeat. Measuring the rate of heartbeat with the smart-watch application, the smart-watch sends this data to the smartphone. On the smartphone side, the smartphone draws a graph on screen using the received heartbeat rate data. The graph is capable of enlargement, reduction and movement, because when you want to watch whole or detail of the graph, expansion reduction and movement to the side are necessary. Figure 4 displays the numerical value that I measured with a smart watch as a graph to the screen of the smartphone. We think that the raise and downs of heartbeat may be normal by making the value that I measured a graph. In addition, smartphone creates a data file of the heartbeat rate. This data file can be accessed by other applications and devices such as another smartphone, computer and so on. It is able to share heartbeat data and see the same graph or data.

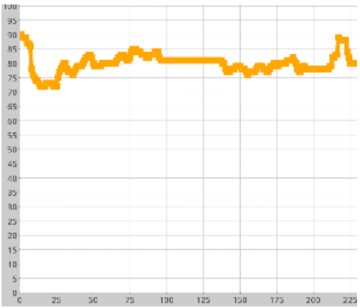

Figure 4. A graph of captured heartbeat on a smartphone screen

3. DISCUSSION

We think that these two kinds of applications that we developed may be useful for students with any disorder/disability. For example, in the case of the student where it is difficult for them to understand feelings by the expressions of other people, and for metacognition of one's own expression, the student can practice making some expressions and the teacher can see the students expression. In addition, in the case of the student that it is difficult to take communication to other people and to grasp feeling of other people, teacher remember the situation that the student has a heightened feeling and calm the student down.

4. CONCLUSION

We developed two kinds of application software to run on a mobile/wearable device for the student who needed special support. The first application allows the user to practice making face-expressions in accord with particular situations. We think that they can practice making face-expressions and read feelings from face-expression through the connection between face-expression and feelings by using this application. The second application is to measure the rate of heartbeat. We think a teacher can understand the situation of heightened feeling of the student who is difficult to communicate with by using this application. In addition, we think that a teacher can take prior measure because a teacher will be able to grasp the situation when a student is exited under control.

We think that these two applications help students who have any disorder/disability in which it is difficult to read the feeling of other people, to make face-expression and to take communication.

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ANALYSIS OF USAGE TRENDS OF SOCIAL MEDIA AND SELF-ESTEEM BY THE ROSENBERG SCALE

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ABSTRACT

The spread of SNS has changed communications between people to a great extent. For them it is a place their hearts can rely on and where they can hang out, a place for self-approval, for self-expression and a place where the other person listens to their dissatisfaction and discontent. At the beginning people are interested in knowing what everyone is doing, so they check SNS every day. However, they feel gradually tired. Immediate response syndrome refers to the feeling of having to check SNS sites and being is a state of psychological imbalance. Some have a loss of self-esteem in the SNS communication. So I analyzed the relationship of social media use and the self-esteem. As a results, the high self-efficacy group prefers both Facebook and LINE while the low self-efficacy group tends to use Twitter.

KEYWORDS

SNS, Communications, self-esteem, Rosenberg self-esteem scale, Facebook, Twitter, LINE

1. INTRODUCTION THE IMMEDIATE RESPONSE SYNDROME

The spread of SNS has changed communications between people to a great extent. At the beginning people are interested in knowing what everyone is doing, so they check SNS sites while eating, working, studying and commuting then they become tired of doing so. These factors are shown in ranks 1 and 2. Immediate response syndrome refers to the feeling of having to check SNS sites and being is a state of psychological imbalance. People who respond immediately become friends but those who reply 15 minute later may have their friendship terminated and their messages refused. It seems that not responding within 15 minutes (or even 30 minutes) leaves the person out of the young people network. It is important to reply before everyone else to show the other person that they are their best friend. And instead of using emails that they do not know when they can be received, the number of teenagers becoming desperately attached to mobile phones on standby in survival mode which they can use eating, having a bath, studying or at any moment is increasing. There are cases when the troubling internet based bullying can be caused by not responding immediately. The birth of the immediate response syndrome is one pathological aspect of SNS culture.

Youths who use e-mail and SNS chat sites frequently and who fall to immediate response syndrome tend to send messages which do not relate to them, have imbalanced mutual understanding and make a lot of mistakes. Being flooded by messages and receiving threats due to misunderstanding is very common.

On the other hand, there are cases when someone decides not use smart phones or the internet regularly as a communication tool like people in the same age group around them, these people find that there is a lot of bad talk about them on SNS posts and they find themselves alone before they know it. This may lead to truancy or may lead to suicidal tendencies in some victims when they see that there were hundreds or even thousands of of bad postings about them spread in a short time.

Moreover, there is a function for checking who read a message in group chats. There are various ways of display such as “seen” or “unread” marks. These marks make it possible to see if the other person has read the message or not. So, when someone reads a message but does not reply, they are called KS(**K**IDOKU **S**URU: Seen through or read and ignored) which may leads to anger and troubles.

In October 2013, a 19 year old male student in Yamagata district in Hiroshima Prefecture, studying at a correspondence high school was repeatedly kicked and punched and had his legs tied and thrown into a river. When he crawled out of the water he had his legs burned with a lighter. The perpetrators were 4 young friends of the victim between 16 and 17 years old. The male student suffered blows to his whole body and needed skin graft operations. The reason for this torture which was treated as an attempted murder was a result of one of the four 16 to 17 year old youths messaging the victim on the smart phone free application, LINE, and the victim not responding. The four young perpetrators committed such a sadistic act on the youth because their message was ignored and there are other more hideous than torture committed in Edo Period.

2. SURVEY SUMMARY

Self-efficacy is the ability to take correct action needed for certain situations. It is generally believed that there are many benefits to having a positive view of the self. Those who have high self-esteem are presumed to be psychologically happy and healthy (Branden, 1994; Taylor & Brown, 1988), whereas those with low self-esteem are believed to be psychologically distressed and perhaps even depressed (Tennen & Affleck, 1993). The feeling of success becomes higher as the feeling of self-efficacy rises, but the feeling of not being able to do something because one cannot use their self-efficacy properly in regard to positive feelings leads to falling into negative thinking. Isn't is possible to be positive and use one's high self-efficacy instead of falling into a vicious circle with no exit? This study reflects on the aspect self-efficacy and SNS.

A questionnaire survey was used to gather information on the use of mobile devices and PC. Survey participants included 1,032 male and female who had agreed to participate in a questionnaire survey. Their ages ranged from 20 to 59. The survey was conducted from March 14 to March 17, 2014.

The survey question was, 'Rosenberg Self-esteem Scale' and 'social media use [LINE, Facebook, Twitter; average using time every day (minutes)]'.

1) Rosenberg Self-esteem Scale

A 10-item scale that measures global self-worth by measuring both positive and negative feelings about the self. The scale is believed to be uni-dimensional. All items are answered using a 6-point Likert scale format ranging from strongly agree to strongly disagree.Below is a list of statements dealing with your general feelings about yourself. Please indicate how strongly you agree or disagree with each statement. Scoring: Items 2, 5, 6, 8, 9 are reverse scored. Give "Most Strongly Disagree" 1 point, "Strongly Disagree" 2 point, "Disagree" 3 points, "Agree" 4 points, "Strongly Agree" 5 pointsand "Most Strongly Agree" 6 points. Sum scores for all ten items. Higher scores indicate higher self-esteem.1. On the whole, I am satisfied with myself. 2. At times I think I am no good at all. 3. I feel that I have a number of good qualities. 4. I am able to do things as well as most other people. 5. I feel I do not have much to be proud of. 6. I certainly feel useless at times.7. I feel that I'm a person of worth, at least on an equal plane with others. 8. I wish I could have more respect for myself.

9. All in all, I am inclined to feel that I am a failure. 10. I take a positive attitude toward myself.

2) Social media use

Please tell us how frequently you use the mobile device functions and apps listed below. Facebook/LINE/Twitter/Mixi. Please tell us how frequently you use the PC and apps listed below. Facebook/LINE/Twitter/Mixi.Mobile devices include smartphones, cellphones, gaming devices that can connect to the Internet, and computers." Responses indicating frequency of use were denoted on a six-point scale (6: Often; 1: Never).

3. RESULTS

Mean and standard deviation for each item of Self-Esteem are shown in Table 1. This later, using the combined value of the item of Self-Esteem, because Cronbach Confidence coefficient was α =.885. And the combined value of the item of SELF-ESTEEM was in accordance with the normal distribution. Therefore, I was a grouping combined value of the item of Self-Esteem, 34 below the low group, more than 35 high group, and using the analysis of variance.

About using SNS with mobile devices, the one factor analysis of variance for the use of each SNS with mobile devices and "combined value of SELF-ESTEEM". The results were as follows.Using Facebook with mobile device's × SELF-ESTEEM; $F(1,1030)=6.65$ ($p<.01$).Using Twitter with mobile device's × SELF-ESTEEM; $F(1,1030)=4.80$ ($p<.05$)Using Mixi with mobile device's × SELF-ESTEEM; $F(1,1030)=4.53$ ($p<.05$).Using LINE with mobile device's × SELF-ESTEEM; n.s. The high group of self-esteem use of Facebook has tended to be higher than the low group.The low group of self-esteem use of Twitter and Mixi has tended to be higher than the high group.The number of people using Facebook, Twitter, Mixi was examined for each of the two Self-Esteem groupings as shown in Table 2. Further I showed average comparison in Figure 1.

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Table 1. Mean and standard deviation for each item of Self-Esteem

	Mean	SD	N
1. On the whole, I am satisfied with myself.	2.84	1.461	1032
2. At times I think I am no good at all.	3.40	1.693	1032
3. I feel that I have a number of good qualities.	3.07	1.412	1032
4. I am able to do things as well as most other people.	3.69	1.424	1032
5. I feel I do not have much to be proud of.	3.68	1.609	1032
6. I certainly feel useless at times.	3.54	1.666	1032
7. I feel that I'm a person of worth, at least on an equal plane with others.	3.30	1.507	1032
8. I wish I could have more respect for myself.	3.27	1.513	1032
9. All in all, I am inclined to feel that I am a failure.	3.42	1.676	1032
10. I take a positive attitude toward myself.	3.32	1.464	1032

Table 2. Facebook, Twitter, Mixi use of each high group and the low group of SELF-ESTEEM

		N	Mean	SD
Facebook	Low group	529	1.83	1.607
	High group	503	2.10	1.799
	All	1032	1.96	1.708
Twitter	Low group	529	2.01	1.769
	High group	503	1.78	1.563
	All	1032	1.90	1.675
Mixi	Low group	529	1.61	1.373
	High group	503	1.44	1.133
	All	1032	1.53	1.264

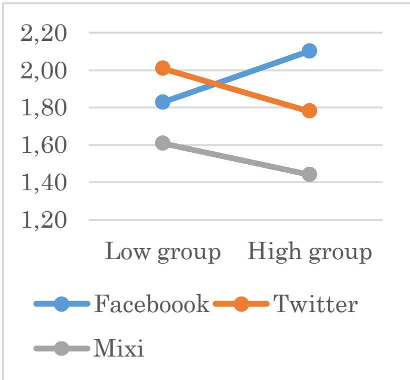

Figure 1. Average comparison of Facebook, Twitter, Mixi use of each groups

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Doctoral Consortium

A MODEL FOR AN INFORMATION SECURITY RISK MANAGEMENT (ISRM) FRAMEWORK FOR SAUDI ARABIAN ORGANISATIONS

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ABSTRACT

Countries in the Gulf represent thriving, globally important commercial centres. They have embraced technology and modern management methods, often originating in the western countries. In adapting to quite different cultures these do not always operate as successfully. The adoption and practices of the Information Security Risk Management (ISRM) frameworks are an example. Although ISRM has become a standard in information security for much of the world, its uptake in the Gulf countries has been poor. This study tests the possibility that this may be due to cultural "biases" built into the operation and structure of the framework. Using a Design Science approach it aims to develop a modified ISRM framework that incorporates a cultural dimension. This will lead to an increased acceptance of ISRM in Gulf countries, and also to allowing it to be used in other non-western cultures. Centring on Saudi Arabia as a typical example of a Gulf culture, a qualitative approach will be adopted. Data will be collected through structured interviews with information security experts in Saudi Arabian organisations, system integrators and vendors. These will focus on cultural dimensions of parts of the ISRM framework and business responses that result. The modified framework developed through this method will be confirmed using focus groups.

KEYWORDS

Information Security Management, Cyber Security, Risk Management

1. INTRODUCTION

Managing information security risk is becoming more challenging. Countries around the world allocate a huge budget for their IT infrastructure and its security; however, without a proper security risk management they will be under high risk of cyber-attacks and data breaches regardless of how big the allocated budget is. There are many well established international approaches and methodologies adopted by organisations to help them to make appropriate decisions that mitigate their information security risk. The very widely adopted Information Security Risk Management (ISRM) framework represents a common approach. ISRM has much in common with other security approaches. However, it doesn't consider regional and cultural factors and assumes that all organisations operating large systems requiring sophisticated formation security measures work the same way.

In Gulf countries for example, identifying an organisation's assets as well as team members' lack of experience, while they are accepted as major factors of information security risk management, are culturally more sensitive in this country, and consequently much more difficult to decipher (AbuSaad et al., 2011). This and other difficulties have impacted the uptake of ISRM in businesses in this region, notwithstanding that such businesses are very enthusiastic about adopting modern practices, boast modern of infrastructure and technology, have well developed management expertise, and no shortage of capital to implement their initiatives.

Despite this there is a gap in scholarly and professional research into information security risk management in these countries, and in others in the Middle East with similar cultures. This applies too to Saudi Arabia, which is the focus of this proposed study. This research will develop the existing ISRM frameworks to introduce culture dimensions, in particular those that applying to Saudi Arabia and other Gulf Countries, with the aim of improving its uptake and success in those countries. An appreciation of culture in the ISRM framework will also improve its use for many other non-Western organisations and can possibly lead to changes even amongst core users.

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2. BACKGROUND

Managing organisations' information security is very crucial and failure to do so may result in disclosure, disruption, modification, or destruction of critical information. This could lead to negative impacts on an organisation's finance, reputation and/or image (McCumber, 2004). The total cost to the global economy from cyberattack data breach is more than $400 billion a year.

With more than 29,000 breached records in 2014, Saudi Arabia and United Arab Emirates companies have a much higher average number of breached records compared to the global average of 23,078; more than 26.5% higher than the global average (Ponemon Institute, 2015). Unlike many other developed countries (Saudi Arabia is considered a developed country, though not a Western one), it has adopted e-services including e-government and e-commerce.

It is naturally becoming much more exposed to cyber-attack. In addition, the Saudi Arabia political conflicts with its neighbour countries including Israel and Iran have increased cyber espionage in the region, and Saudi Arabia is sensitive to this threat. In June 19, 2015 more than 500,000 cables and emails from the Saudi Foreign Ministry, including many "Top Secret" reports from the Saudi's General Intelligence Services have been breached after an attack by the so-called the "Yemeni Cyber Army" (Blake, 2015).

It is therefore clear that Saudi Arabia appears to be at more risk of security breaches, and have a higher impact per breach than the global average. Because of its and its neighbours' importance in global trade, commodities, finance and logistics, risks to these countries tangibly increase the overall global risk level.

2.1 Risk Management

Risk is defined as "the effect of uncertainty on objectives" that can be described as "the combination of the likelihood of an event and its consequence" (ISO/TR31004, 2013). It measures the potential condition or event an entity could be threatened by, including the negative impacts that would come along if the event occurs and the occurrence probability or likelihood of these occurring. Risk management is the process of risk identification, assessment, and reduction to an acceptable level (Stoneburner, 2002).

2.2 Information Security Risk Management (ISRM)

Information security involves "protecting information from unauthorized access, use, disclosure, disruption, modification, or destruction" to accomplish organisation's confidentiality, integrity, and availability of information. Information Security Management (ISM) is an information security process that:
1) identifies the organisation's IT environment and its criticality and prioritising its involvements to the organisation's business capabilities.
2) identifies all possible IT security risks, assesses, and finally mitigates them.
3) provides frequent improvement of the organisation's security risk position (Raggad, 2010).

A Crucial component of Information Security Management is risk management, which itself has become a formal component of ISM referred to as Information Security Risk Management (ISRM) and defined as "the process of identifying vulnerabilities and threats to the information resources used by an organisation in achieving business objectives, and deciding what countermeasures to take in reducing risk to an acceptable level, based on the value of the information resource to the organisation" (Raggad, 2010).

2.3 Current ISRM Approaches and Methodologies

ISRM is not a new research domain. Other mechanisms have been used for some time. As long ago as 1975, Annual Loss Expectancy (ALE) had been proposed by the US National Bureau of Standards for measuring IT risks. ALE was very basic and could not distinguish between high or low impact of events. After a series of workshops in the 1980s by the US National Bureau of Standards, ALE evolved into an iterative process for information security risk management with the following steps: requirements identifications, threats analysis, risk measurement, acceptance test, protection and implementation. The following ISRM methodologies are the most adopted and widely in use today.

2.3.1 NIST 800-39

National Institute of Standards and Technology NIST a part of the United State Department of Commerce has developed information security framework for the federal government and its contractors. The idea is to enhance information security and improve risk management processes (Ross et al., 2011). NIST 800-39 includes four main components: framing risks, assessing risks, responding to risks, and monitoring risks (Fenz et al., 2014).

2.3.2 OCTAVE

Operationally Critical Threat, Asset and Vulnerability Evaluation (OCTAVE) was developed by CERT Coordination Centre (Vorster and Labuschagne, 2005). It is an ISRM framework that provides organisations with processes to understand, assess and address their information security risks from their internal perspective. It is a methodology that identifies, prioritises and manages information security risks.

2.3.3 ISO/IEC 27005

This International Standard provides guidelines for information security risk management. It supports “the general concepts specified in ISO/IEC 27001 and is designed to assist the satisfactory implementation of information security based on a risk management approach”. It can be adopted by all types of organisations including commercial enterprises, government agencies, etc. (ISO/IEC27005, 2011). ISO/IEC 27005 divides information security risk management into three main phases: risk assessment, risk treatment and risk acceptance.

2.3.4 CRAMM

The reason behind the development of “Central Computer and Telecommunications Agency” Risk Analysis Management & Methodology (CRAMM) was the need for a subjective and vulnerability driven information security risk management methodology. CRAMM focuses primarily on technical security aspects and the main phases are identification and evaluation of assets, assessment of threat and vulnerability, and selection and recommendation of countermeasure. One of the CRAMM main issues that it has been developed focusing on large (Fenz et al., 2014).

2.4 Information Security in Saudi Arabia

The latest Kaspersky report (2014) categorises Saudi Arabia as “High Risk” with 53% infected personal computers and 36% of connected users facing cyberattacks. Cyber threats are also large. For example, Saudi Aramco, the world’s largest oil producer, had a catastrophic cyberattack in 2012. Its computer network was struck by a very aggressive virus, Shamoon, which damages as many as 30,000 computers, deleting all hard drive data. It took about two weeks to recover and cost the company millions of Dollars to rectify (Bronk and Tikk-Ringas, 2013). Most of Saudi Arabian organisations focus on information security technologies rather than the human aspect to protect information assets from any vulnerability that could lead to possible data breach or attacks (Alzamil, 2012), which represents improper ISRM implementation. The total ICT spend in Saudi Arabia in 2015 could reach $36.95 Billion according to International Data Corporation's newly released predictions (McBride, 2015). That means the country spends an adequate amount of money on its IT security and infrastructure; however, managing IT is not a success.

2.5 Information Security Culture in Saudi Arabia

Studies by (Alarifi et al., 2012) show there is a far higher level of creating very simple passwords in Saudi Arabia 45% compared to South Africa, which is only 9.1%. As well, 35.8% people share their passwords with others in Saudi Arabia compared to 0% in South Africa. In addition, 65.7% Saudis have never changed their passwords compared to only 27.3% in South Africa. Poor IT planning, lack of expertise, and low levels of management support as well as cultural and social barriers are the major information security problems in Saudi Arabia (Alnatheer, 2012). Employee behaviour has a big impact on information security in organisations. It has been disclosed that 80% of security failures were the result of weak employee’s security behaviour. It has been supported by other studies in which most of information security threats are initiated

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by irresponsible employees who do not follow information security policies and procedures of their organisations. "Cultural concept can help different segments of the organisation to concern about the information security within the organisation" (Lim et al., 2009). Social and cultural characteristics of Arab and Muslim countries are different from the West countries. Professional aspects and deals with IT acceptance (of which ISRM is a component) are affected by social and cultural characteristics (Al-Gahtani, 2004).

2.6 Evaluating ISRM Adoption in Saudi Arabian Organisations

Global distribution of ISO/IEC 27001 certificates in 2013 survey (2014) shows that out of 22,293 ISO 27001 certified companies around the world, there are only 59 Saudi Arabian certified companies. ISRM has a very poor uptake in this country. AbuSaad et al. (2011) have studied 8 out of 13 ISO 27001 certified Saudi Arabian organisations. They concluded that during the ISRM implementation phase, identifying the organisation's assets and team's lack of experience are the major obstacles. Another study by AbuMusa (2009) revealed that more than 60 percent of respondents stated that managing information systems are not audited in Saudi Arabian organisations.

Perhaps in line with the poor adoption of ISRM in Saudi Arabia there is little evidence of relevant research in the context of that country or indeed of other Gulf countries. This study will add to the knowledge base and as scaffolding for further research and practice with regard to regional cultures. It will also make a contribution in comparative studies between western and Middle Eastern countries and deliver a better understanding of the mechanisms at work in both areas. It will develop the existing ISRM frameworks for Saudi Arabia organisations to allow them to contribute to improved risk management of information security. Also, it will evaluate current ISRM adoptability in Saudi Arabian organisations and will reveal ISRM critical success and failure factors in Saudi Arabian organisations.

3. RESEARCH METHOD AND RESEARCH QUESTIONS

A design Science approach is proposed in this study. Venable (2006) states that Design Science Research (DSR) provides "constructs, models, methods, instantiations, and better theories". According to Hevner et al. (2004), design science research points serious and unresolved problems in innovative or unique ways or resolved problems in more efficient or effective ways. This research lends itself well to a Design Science Research "DSR" methodology in developing a localized, culturally sensitive and applicable ISRM framework.

Specifically, the following research questions are addressed:

1. What are the key success and failure factors of effective ISRM implementation in the Saudi Arabian context?
2. What are the critical cultural, social and technological factors that must be considered for developing ISRM framework for Saudi Arabian organisations?
3. How could Saudi Arabian enterprise organisations improve their information security risk management using the newly adopted and developed ISRM framework?

This research will be divided into five phases to accomplish its objectives as follows:

Phase 1 - Problem Formulation and Identification:

Stage One: Literature Review

Stage Two: Gathering Data using semi-structured interviews. This research will involve semi-structured interviews as primary source of data in order to evaluate the current state of ISRM in Saudi Arabia and understand the information security problems and challenges faces organisations. This stage will be divided into two parts:

1) Interviewing Saudi Arabian organisation CIO's, IT managers, security engineers and security analyst to identify the problem and evaluate ISRM current state in participants organisations
2) Interviewing IT vendors and systems integrator and software's developer companies in Saudi Arabia to triangulate findings and identify gaps

Phase 2 - Data Analysis **-** Theory Building: The data collected from the semi-structured interviews and the literature will be analysed to identify critical ISRM factors necessary for Saudi Arabian organisations in order to build the theory and identify gaps.

Phase 3 - Developing New Framework – Purposeful Artefact Design: This phase will manage and control the problems identified in the previous phase. A new integrated coherent ISRM framework for Saudi Arabian organisations will be develop based on previously developed international ISRM frameworks

Phase 4 - Focus Groups **-** Purposeful Artefact Evaluation: In Design Science Research, evaluation is considered as a key activity (Hevner et al. 2004). The new ISRM framework will be reviewed and evaluated by focus groups and used to further refine the new framework. A set of three focus groups from different Saudi Arabian companies will be going over the new ISRM framework and provide their feedback and comments. Each focus group will be five to seven participants including CIO's, IT managers, security engineers and security analyst. The Methodology for Evaluation in Design Science (MEDS) will be adopted in this phase to evaluate the new ISRM framework

Phase 5 - Enhancing and Confirming New Framework **-** Purposeful Artefact Design: The feedback and results provided by focus groups will be further enhance and finalize the newly developed ISRM framework for Saudi Arabian enterprise organisations.

4. RESEARCH OUTCOME

There is little evidence of ISRM research in a Saudi Arabian context and development of this framework will add to the knowledge base for further research and practice, and in an extension of knowledge in ISRM in Saudi Arabia, and due to its cultural, commercial and economic similarities to other countries in the Arabian Gulf region, serve as a base for comparative studies between western countries and Middle Eastern countries. This research will develop the existing ISRM frameworks for Saudi Arabia organisations that will improve risk management of information security. Also, it will evaluate current ISRM adoptability in Saudi Arabian organisations and will reveal ISRM critical success and failure factors in Saudi Arabian organizations. Review of literatures and one-to-one interviews will be the primary raw data to build the new ISRM framework based on current ISRM frameworks where focus groups will ensure the framework practicality.

5. CONCLUSION

In conclusion, this research will provide improved ISRM framework implementation and effectiveness in enterprise organisations in Saudi Arabia, with further relevance to other Gulf countries. Also, it will increase the knowledge base of ISRM in Saudi Arabia to assist organisations in Saudi Arabia to adopt ISRM and implement it more effectively and mitigate information security risk to acceptable levels.

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