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A Web-Based Collaborative e-Learning Environment Based on a Model of Social Cognitive Development Theories

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**A Thesis Submitted in Partial Fulfillment of the Requirements for
the Degree of Master in Information Technology**

1433/201

Acknowledgment

It is quite hard to believe this will be the final step towards receiving my Master's degree in Information Technology after an academic journey of continuous eight years at the Islamic University of Gaza. Starting from Bachelor program in Information Technology, then a diploma in Education and ending with Master program in Information Technology. It was a rich experience which truly enriched my life in many ways and allowed me to learn a lot and also made many good friends.

All thanks and praises to Allah who granted me the strength, support, guidance and eased the difficulties which I faced during the accomplishment of this thesis. I would like to take the opportunity to thank a few people for making this thesis possible. First of all, I would like to thank Dr. Rebhi Baraka for his supervision, advice, time and constructive feedback. Furthermore, much appreciation to my parents and my family for their love and continuous support. Special thanks go out to my friend Mrs. Lamiya El-Saedi who has been a great support to me. Thank you for motivating me and being there for me whenever I felt lost

Abstract

Putting all powerful Web technologies like Cloud Computing and Web 2.0 technologies together in an e-learning environment maximizes the opportunity for learners to acquire knowledge and skills in an interactive, collaborative and social manner and decreases technical efforts and financial burdens on educational institutions.

This research proposes a collaborative e-learning model that consists of six levels and six tasks based on four social cognitive development theories which are: Connectivism, Social Cognitive Development, Social Interdependence and Cognitive Elaboration Perspectives. The proposed collaborative e-learning model levels are: *Networking, Contribution, Cognitive Disequilibrium, Origination of Social Interaction, Knowledge Evolving, and Cognitive Equilibrium*. The tasks of the proposed collaborative e-learning model are: *Knowledge Feeding, Knowledge Self-Reflection, Knowledge Negotiation, Knowledge Elaboration, Knowledge Accommodation and Knowledge Shifting*.

A rich Web-based collaborative e-learning environment called ShareSpace is developed as a realization of the proposed collaborative e-learning model. ShareSpace is evaluated based on the proposed collaborative e-learning model, on a framework for evaluating computer supported collaborative learning and on an adaptable usability heuristic checklist for online courses. ShareSpace is an interactive and flexible social collaborative e-learning environment which can be utilized by educational institutes and contributes to the overall goal of learning process which is maximizing the learning outcome.

Keywords Collaborative e-Learning, Social Cognitive Development Theories, Web 2.0, Cloud Computing.

عنوان البحث

بيئة للتعلم التعاوني الإلكتروني مستندة على نموذج من نظريات النمو المعرفي الاجتماعي

الملخص

دمج تقنيات الويب الحديثة مثل الحوسبة السحابية و الويب 2.0 معا في بيئات التعليم الإلكتروني يزيد من فرصة المتعلمين لاكتساب المعرفة والمهارات بطريقة تفاعلية ولتعاونية واجتماعية ، كما ويخفف من الجهود التقنية والأعباء المالية على المؤسسات التعليمية.

هذا البحث يعرض بيئة للتعلم التعاوني الإلكتروني تسمى ShareSpace والتي تم تصميمها وتطويرها على أساس نموذج مقترح معتمد على نظريات النمو المعرفي الاجتماعي (Social Cognitive Development Theories). يتكون هذا النموذج من ست مستويات وهي : التشبيك، الاسهام، عدم الاتزان المعرفي، نشأة التفاعل الاجتماعي، تطور المعرفة و الاتزان المعرفي. كما يتضمن النموذج ستة مهام وهي: تغذية المعرفة، الانعكاس الذاتي عن المعرفة، تفاوض المعرفة، بلورة المعرفة، استدامة المعرفة و انتقال المعرفة.

تم تقييم مرونة وتفاعلية ShareSpace اعتمادا على إطار لتقييم التعلم التعاوني الإلكتروني وقائمة كشف قابلية الاستخدام لبيئات التعلم الإلكتروني (Usability Heuristic Checklist). و تبين من التقييم أن ShareSpace بيئة تعلم تعاوني مرنة وتفاعلية واجتماعية. إن استخدام مثل هذه البيئة يساهم في الهدف العام للتعليم المتمثل في تحقيق واستدامة أقصى قدر من مخرجات التعلم.

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List of Abbreviations and Glossaries

CBCS	Cloud Based Collaborative Services
CSCL	Computer Supported Collaborative
CSCW	Computer-Supported Cooperative Work
HTML	Hyper Text Markup Language
ICT	Information and Communications Technology
LMS	Learning Management System
MKO	More Knowledgeable Other
MOODLE	Modular Object-Oriented Dynamic Learning Environment
Q&A	Question and Answer
SCL	Student Centered Learning
SCORM	Sharable Content Object Reference Model
SDK	Software Development Kit
SLE	Synchronous Learning Environment
UGC	User-Generated Content
ZPD	Zone of Proximal Development

Chapter 1

Introduction

This chapter introduces the thesis by stating the underlying concepts of collaborative e-learning and the requirements of building collaborative e-learning environments, the thesis problem, the research objectives, the importance of the research, the scope and the limitations of the research, as well as the research methodology.

1.1 Collaborative e-Learning

Learning refers to the process of acquiring new or modifying existing knowledge, behaviors, skills and values and it may also involve synthesizing different types of information [32]. The concept of traditional education does not fit well with the new world of lifelong learning in which the roles of instructor, students, and curriculum are changing. The traditional style of learning process is limited within the walls of classroom. It is restricted by time and place limitations with high teacher's centralization and limited student's participation [34]. The teacher initiates, manages, directs and controls the educational process. Most of the time the teacher's role is a knowledge sender and the student's role is just a passive receiver of this knowledge. Many education researchers and pedagogy experts argue that the teacher-centered model is limited as a learning process since the concept of perfect learning requires the student contribution of learner in classroom activities [38].

The evolution of social cognitive development theories such as: Connectivism [17], Social Cognitive Development[26], Social Interdependence[13] and Cognitive Elaboration Perspectives [16] led to create, design and deliver the educational curriculums in new ways taking into account the learner and his interaction with his peers through collaborative learning sessions. Collaborative learning emphasizes the role of learner interaction in the classroom. The learning process becomes social and interactive such that the learner acquires the knowledge and skills through talking to his peers, commenting on their contributions, discussing different perspectives about a learning topic and as well as sharing learning

resources with them. This modified interaction help in creating cooperative, collaborative, interactive and high effective learning environments [32]. Collaborative learning moves the students and the learning process at all beyond the classroom walls. Adopting collaborative learning in classroom replaces the teacher-centered learning with student-centered learning (SCL). SCL, as the term suggests, is a method of learning or teaching that puts the learner at the centre [28].

One of the most significant factors that reshapes and redefines the traditional educational process is the rapid and the huge revolution of information and communication technology which led to the enhancement for the traditional learning process by the wide and strong adoption of e-learning in educational institutes.

E-learning is commonly refers to the intentional use of networked information and communications technology in teaching and learning [22]. E-learning has four different modalities namely: offline individualized self-paced e-learning, online individualized self-paced e-learning, synchronous group-based e-learning, asynchronous group-based e-learning [34]. In the first and second modalities the learner learns lonely in his own pace and his interaction with the learning resources is the only interaction he performs during the learning process. Learning Management System (LMS) is a best example of the first and second modalities. In the third and fourth modalities the learner is engaged in a group of learners in which he shares the learning resources with peers within the same group. The learning process becomes team-dependent that every member contributes in the learning tasks and shares part of the learning resources. Synchronous group learning brings the collaboration and the interactivity to the learning process which leads to better knowledge exchange and effective learner participation that maximize the learning outcome.

An extended shape of group e-learning is called a collaborative e-learning that refers to constructing knowledge, negotiating meanings and/or solving problems through mutual engagement of two or more learners in a coordinated effort using Internet and electronic communication [22]. *Constructing knowledge, negotiating meanings and/or solving*

problems mean learning together in meaningful ways that use and develop higher order thinking skills. *Mutual engagement* means all are participating in shared work with accountability reciprocity. *Two or more learners* mean these are activities that engage pairs or groups of learners. Others may also be a part of the collaborative e-learning activity including the instructor or others involved in applied or service-learning projects. *Coordinated effort* means the project is purposeful and meshes with curricular goals. *Internet and electronic communications* mean learners use synchronous or asynchronous tools such as email, Web conferencing, instant messaging, virtual worlds, wikis or discussion forums.

Collaborative e-learning is a learner-centered e-learning in which learning is an active process rather than a result of transmission of knowledge from teacher to student [1]. In collaborative e-learning environments informal learning is conducted freely such that learners acquire knowledge and skills in their own pace. They learn from each other by engaging in an online learning community where there are ample opportunities for learner-to-learner discussion, collaboration, and feedback [18].

Designing and building effective collaborative e-learning environments require the combination of two key perspectives which are the pedagogical perspective and technological perspective [37]. Pedagogical perspective emphasizes that knowledge is the result of learners interacting with each other, sharing knowledge, and building knowledge as a group of collaborative e-learning. This perspective has its roots in social cognitive development theories [30]. Technological perspective emphasizes that learning consists of retrieving information from self, others and machines, collaborating to create knowledge, and applying information to current contexts using ICT techniques [4].

In this research a collaborative e-learning model which consists of six levels is proposed based on four social cognitive development theories namely: Connectivism, Social Cognitive Development, Social Interdependence and Cognitive Elaboration Perspectives. The six levels of the proposed model are: *Networking, Contribution, Cognitive Disequilibrium, Origination of Social Interaction, Knowledge Evolving, and Cognitive Equilibrium.*

The proposed collaborative e-learning model has six tasks which are: *Knowledge Feeding, Knowledge Self-Reflection, Knowledge Negotiation, Knowledge Elaboration, Knowledge Accommodation and Knowledge Shifting*. The model design considers the cognitive development of the learner, the social interdependence interaction between learners and the peer information processing.

A Web collaborative e-learning environment called ShareSpace is developed to realize the proposed model and is evaluated to ensure its interactivity and flexibility. The motivation behind conducting this research is to give a strong emphasize to the value of social collaborative mechanisms in creating better knowledge exchange between learners.

1.2 Problem Statement

The main problem which this research addresses is how to develop an online e-learning environment which supports the collaborative exchange and the collaborative construction of knowledge with high learner's individual participation and intensive social interaction between the joined learners in this environment.

1.3 Objectives

The following sections present the main objective and the specific objectives of the thesis

1.3.1 Main Objective

The main objective of this research is to utilize the social cognitive development theories in enhancing the collaborative e-learning process.

1.3.2 Specific Objectives

The specific objectives of this research are as follows:

- Specify the requirements and features of the collaborative e-learning environment.
- Design the collaborative e-learning model based on the social cognitive development theories.
- Conduct a learning scenario as a proof of concept for the model.

- Build a collaborative e-learning environment to realize the collaborative e-learning model
- Evaluate the collaborative e-learning environment based on the proposed collaborative e-learning model, on a framework for evaluating computer supported collaborative learning and on an adaptable usability heuristic checklist for online courses.

1.4 Importance of the Research

The importance of this work comes from:

- The developed e-learning environment will enhance the existing e-learning environments by taking into account the social aspects of the learning process.
- The proposed model will be introduced as a true realization of the social cognitive theories.
- Faculties can utilize it in practical courses which require team work such that instructor and learners can keep and maintain the interactivity of the learning process.
- Companies can get benefit from this work as a rich training tool to promote the effective collaborative work among the company activities and follow up the progress of the shared projects.

1.5 Scope and Limitations of the Research

This work is expected to be developed under some constraints and limitations such as:

- It is a hosted Web based application.
- The collaborative e-learning environment will be developed independent of any LMS.
- The evaluation and assessment of the learner's participation and the collaborative outcomes are beyond the current scope of this research and might be considered in the future works. Instead an evaluation of the developed collaborative e-learning environment will be conducted.

1.6 Research Methodology

This research follows a methodology that consists of four stages as follows:

- **Stating the theoretical foundation:** In this stage, a deep reading, understanding and analyses of the pedagogical theories and the related works which were done in this field will be performed in order to form a clear orientation of the theoretical framework for the Web based collaborative learning environment.
- **Designing the collaborative model:** In this stage, the requirements and the features of the collaborative learning are defined based on the social cognitive development theories then based on these requirements the model of the collaborative e-learning is proposed and designed clearly.
- **Building the Web based collaborative learning environment:** In this stage, the collaborative learning environment which is a realization of the proposed collaborative e-learning model is developed by utilizing Web 2.0 techniques and cloud based services of SharePoint platform.
- **Evaluating the Web based collaborative learning environment:** In this stage, the Web based collaborative e-learning environment will be evaluated in order to ensure its usability and interactivity. The evaluation will be based on the proposed collaborative e-learning model, on a framework for evaluating computer supported collaborative learning and on an adaptable usability heuristic checklist for online courses.

1.7 Thesis Structure

This thesis is broken down into seven chapters. Chapter 1 gives an introduction to collaborative e-learning and states the thesis problem, the thesis objectives as well as the thesis methodology. Chapter 2 discusses the related works. Chapter 3 states the theoretical foundation of collaborative e-learning. Chapter 4 presents the proposed collaborative e-learning model. Chapter 5 describes ShareSpace which is a collaborative e-learning environment that realizes the proposed collaborative e-learning model. Chapter 6 presents the evaluation of ShareSpace. Finally, Chapter 7 draws the conclusion and future work.

Chapter 2

Related Works

Collaboration in e-learning environments has been examined in various studies. Some researches addressed the design of general collaborative e-learning environments which can be utilized in any domain of teaching and learning, others design a curriculum-specific collaborative Web-based e-learning environment that is dedicated for a certain course. This chapter presents the related works in collaborative e-learning.

2.1 Wiki Integration with MOODLE

A blended technique combining collaborative forums and Wiki technologies is proposed in [19] to support student interaction and collaboration in E-learning environments. The proposed technique is applied on an e-learning course. The e-learning course is based on the MOODLE open source LMS platform. To implement the proposed technique a special purpose forum is included in each educational section called “collaborative forum”. According to this technique, students are allocated into smaller groups and a research topic is assigned to them. Then, the members of each group exchange ideas and opinions to reach a final answer which will result in new educational material. Their findings are then uploaded into the Wiki platform, creating collective and continuously upgradable course-related knowledge. Its goal is to actively engage students in the learning process, motivating them to research over a specific topic and discuss their findings with their classmates. The effectiveness of the proposed technique is evaluated using student activity data and questionnaire analysis. Results showed that the technique adequately supported teamwork, increasing student motivation and progress while simultaneously producing satisfactory level educational material. The integration of wiki into MOODLE was conducted from a pure technological perspective which aimed to empower MOODLE with social tools.

2.2 A Curriculum-specific Collaborative Web-based e- Learning Environment

In [39] a framework of interactive and collaborative methods are integrated into a Web-based environment for information security curriculum. The framework has four parts: e-classrooms, e-labs, interaction center and resource center. Teachers give lectures to students through the e-classrooms. The e-classrooms are designed to the students who have enough time to listen to the live lectures. The exercises can be done in the e-learning environment through the e-labs. Students complete the exercises individually or they are divided into different teams to complete more complex practice collaboratively. Interaction center provides instant and non-instant interaction methods. Non-instant interaction methods include: assignment, online forum and email. Instant methods include: instant message tools, online Q&A, and online discussions. Resource Center provides students with a rich collection of different types of learning resources such as: slides, courseware, reference books and papers. The collaborative Web-based e-learning environment is investigated and the students' evaluation shows that most students are satisfied with the Web-based e-learning environment.

2.3 Collaborative Remote Laboratory Application

Web technologies were utilized enhance the engineering education by implementing a Web based collaborative experiment on control of a bioreactor environment [36]. The researchers proposed client-server architecture for a collaborative learning model that enables multi user working on remote laboratory application. The architecture consists of Web server; Web based user interface, signal conditioning unit, graphical control system, multimedia features and the experiment. The Web server contains the LabVIEW virtual instruments which were converted into HTML pages and stored in the server's root directory. The Web based user interface enables the learners from remote access to the server's LabVIEW HTML pages using TCP/IP protocol. The signal conditioning unit is an e-electronic circuitry which receives the electrical signals from the temperature and pH transducers and converts them in to suitable range which can be processed by the server. These signals are used to configure the LabVIEW virtual instruments using a control algorithm via a graphical control system. The MS NetMeeting's multimedia features such as: video, audio, whiteboard, file transfer and

text chat were utilized to manage the synchronous interaction between the remote distributed learners. A Web based remote experiment was conducted by configuring the LabVIEW virtual instruments in a collaborative manner. To enhance the security of the on-line learning environment the server was equipped with remote identification and authorization, as well as firewall to keep away eventual attacks.

2.4 RIPPLE (Remote Interactive Pair Programming and Learning Environment)

It is a freely available plug-in in Eclipse SDK, open source software tool that enables two programmers to work remotely on the same Java program at the same time [20]. In RIPPLE the collaborators' views are synchronized over several dimensions. When one user undertakes a supported action, that action generates an event that is transmitted to the remote user. Synchronized actions include file system manipulation, editor operations and program execution. To preserve the low bandwidth requirement, RIPPLE does not transmit more complex features such as mouse pointer location. RIPPLE features textual dialogue support through an instant message- style chat program. In standard instant messaging (such as the kind provided with many popular online chat applications),(both users may construct messages simultaneously and send them when desired. The textual dialogue component of RIPPLE supports enforced turn-taking in dialogue. In this structured mode, only one user may type a message at a time. This setting guarantees that messages appear in the dialogue history in the order in which they were constructed.

2.5 Synchronous Learning Environment (SLE)

It is a sample implementation of a synchronous collaboration environment which enables members of a small group working together efficiently via computer networks [8]. Its information space model was designed based on a three elements communication, cooperation and coordination. The simplest structure for the information space model is a linear array of information objects. These objects could be words, sentences or sections. The linkage between them is provided by their order. For the interaction with the information space, a minimal set of object operations has to be realized: creation, manipulation,

movement, and deletion. Interaction between users takes place through interaction with information space objects, so a small extension to the set of object operations is required: selection and de-selection. For visualization, a workspace is used which comprises all mechanisms of the users interacting in the shared information space. The workspace supported with an additional information channel, which allows the realization of loose and close collaboration. In a loose collaboration, a user must be informed where the other users are acting. In close collaboration, a user must be informed about what the others are doing. SLE was divided into four separable modules: data management, user management, communication, and workspace. The communication module can either be a voice or a video chat depending on user preferences, bandwidth or hardware requirements. The user management module provides user identification and user session handling. The data management module is informed about information space changes and maintains a persistent representation. In the current version, the communication module realizes a simple voice chat. The central element of the SLE is the workspace module. It is built as client-server architecture. The server provides a reference model of the information graph. The clients share the global workspace and are responsible for projection, visualization and interaction.

2.6 Computer Supported Collaborative Work (CSCW)

One of the greatest problems of an interactive learning and working environment of CSCW among remote users is the vast amount of information and files that has to be exchanged in order to ensure a secure and unambiguous interaction. Bouras and Zoura, [2] , introduced a flexible solution to the above problem through a generalized idea of a group of users working together in a shared workspace that provides them with the means of communicating in various ways. The architecture is implemented as a Web based environment for co-operative Tele-working and collaborative learning over TCP/IP networks, such as Internet. The client of the application is obviously a Web browser. The html pages of the application, as well as the session related files uploaded by the users, are stored in the server. The main functionality is the management and centralized control of a number of files of any format that are stored in the server. This functionality is enhanced by means of interactive communication between the users/students, so as to fully satisfy the real-time needs of a group. The user of the CSCW

environment may exploit its communication features independently of the file exchange, rendering it a powerful way of co-operation, adjustable to many distance learning and working scenarios. As a suggestion for later version of the CSCW environment, the user of the CSCW environment is urged to using NetMeeting features like: whiteboard, audio and video and application sharing.

2.7 Collaborative e-Learning System for Biomedical Specialists

Collaborative learning environment provides opportunities for collaborative learning practices and has the ambitious power to realize a continuous training of trainers, learners, technicians and engineers on the biomedical engineering field [14]. A collaborative e-learning system for biomedical specialists has been designed with four main components. Those are Web site, an open source e-learning management system (MOODLE), SCORM compatible packaged course content with interactive 3D models using 3D Max 2008 and synchronous Web based conference system (Dim Dim). Synchronous and asynchronous structure provide meeting point for practitioners, researchers and all those with an interest in biomedical engineering field of vocational education and training. The Web site provides collaboration between all partner organizations. All partners can upload and download information such as news and announcements, documents, presentations, course contents, statistical data and track every change in system. All partners also use system for accessing learning management and synchronous Web based conference system.

2.8 BEST (Bulgarian Educational Site)

BEST [33] is a software environment used for creating, editing, sharing, storing, reusing and managing e-projects which was developed in collaboration between different educational institutions. The BEST system provides the following possibilities that can be used for modeling project-based and collaborative learning: gathering and distribution of information to help teachers and learners share the learning resources, creation of collaborative documents to help the students in writing definitions, analyzing cases, solving problems, writing documents and creating illustrated documents together around specific themes, discussion and commentaries around productions in which learners identify together facts,

principles and concepts and clarify complex ideas; they formulate hypothesis and plan solutions, make links between ideas, compare different points of view, argue, evaluate and project management activities in which learners can design work plans, share tasks, form groups and realize collaborative tasks.

2.9 A framework for Evaluating Computer Supported Collaborative Learning

An evaluation framework is suggested in [6] which can be applied as a broad indicator of the presence or absence of five key features of collaborative learning. The five features are:

- Learner's individual responsibility and accountability which measures the degree of autonomy in student learning,
- Learning interaction is conducted in small groups which examine whether the collaborative e-learning environment promotes collaborative learning or not
- Interactive and dynamic communication which ensure the moving beyond knowledge transmission to include communication as a real life skill
- Learner identifiable role in the learning task which check the promotion of personalization and the reduction of depersonalization of learning.
- A shared understanding within the learning environment which ensure that all the learners are awareness of the learning goals.

The purpose of this framework is to guide the evaluation of collaborative e-learning environments.

2.10 An Adaptable Usability Heuristic Checklist for Online Courses

The adaptable usability heuristic checklist for online courses is a start to offering a comprehensive and expansive list of usability heuristics that ensure the effective usability in the design and use of online courses. An adaptable usability heuristic checklist for online courses is presented in [27]. The checklist includes 13 heuristic categories, including: Visibility, Functionality, Aesthetics, Feedback and Help, Error Prevention, Memorability, Course Management, Interactivity, Flexibility, Consistency, Efficiency, Reducing

Redundancy, and Accessibility. It can be applied to the usability evaluation of online courses that promote collaborative learning since it emphasizes the presence of interactivity and flexibility in these online courses.

The above reviewed works succeeded in building collaborative e-learning environments. Some of these environments were for general use, and the others were developed for specific curriculum. These works concern only with the technological perspective of building collaborative e-learning environments which is not sufficient for maintaining the high degree of interactivity and sociability of the collaborative e-learning process. This research is distinguished from the reviewed works that it proposes a collaborative e-learning environment which combines the two key perspectives of collaborative e-learning which are the pedagogical perspective and the technological perspective.

Chapter 3

Theoretical Foundation

This chapter states the theoretical foundation of the collaborative e-learning. The four learning theories which are Connectivism, Social Cognitive Development, Social Interdependence and Cognitive Elaboration Perspectives are discussed in depth. Based on the previous learning theories a collaborative e-learning model is presented.

3.1 Social Cognitive Development Theory

The social cognitive development theory proposed by the Russian psychologist Vygotsky [26] describes learning as a socio-cognitive process in which the social interaction plays a fundamental role in the development of learner cognition. He believed that everything is learned on two levels first, on the social level through interaction with others (inter-psychological) and second, on the individual level inside the learner (intra-psychological).

Vygotsky formulated the concepts of the More Knowledgeable Other (MKO) and the Zone of Proximal Development (ZPD). The MKO refers to anyone who has a better understanding or a higher ability level than the learner, with respect to a particular task, process, or concept. The MKO is normally thought of as being a teacher, coach, or older adult, but the MKO could also be peers, a younger person, or even computers. ZPD is defined as *“the distance between a child’s actual developmental level as determined by independent problem solving and the higher level of potential development as determined through problem solving under adult guidance or in collaboration with MKO”*. Vygotsky theorized that children maximize learning when they enter this zone. The lower limit of ZPD is the level of skill reached by the child working independently (also referred to as the child’s actual developmental level). The upper limit of ZPD is the level of potential skill that the child is able to reach with the assistance of a more capable instructor [31].

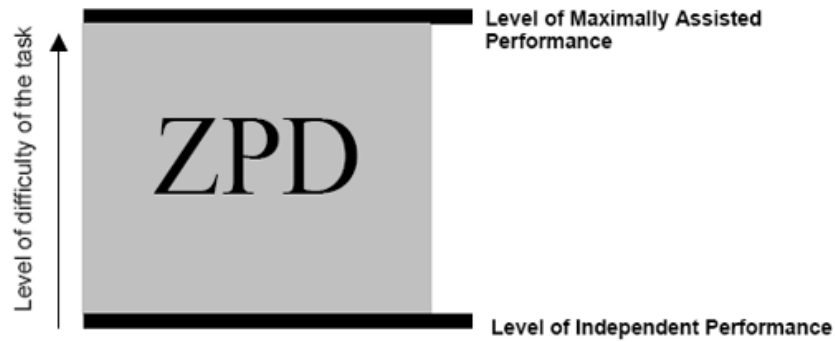


Figure 3.1: Zone of Proximal Development. [11]

Social cognitive development theory emphasizes the interdependence of social and individual processes in the co-construction of knowledge in collaborative learning [21]. Higher mental functions such as reasoning, comprehension, and critical thinking originated in social interactions and are then internalized by individuals. Children can accomplish mental tasks with social support before they can do them alone. Thus collaborative learning provides the social support and scaffolding that students need to move learning forward.

Two key principles derived from Vygotsky's ideas have played an important role in designing collaborative e-learning situations [35]. First is his emphasis on the social nature of learning. He proposed that children learn, through joint interactions with adults and more capable peers. On collaborative learning children are exposed to their peers' thinking process; this method not only makes the learning outcome available to all students, but also makes other students' thinking processes available to all. Vygotsky noted that successful problem solvers talk themselves through difficult problems. In collaborative groups, learners can hear this inner speech out loud and can learn how successful problem solvers are thinking through their approaches. The second key concept is the idea that children learn best the concepts that are in their zone of proximal development. When learners are working together, each learner is likely to have a peer performing on a given task at a slightly higher cognitive level, exactly within the learner's zone of proximal development.

Vygotsky was a big proponent of learning in a social environment, one that harnesses the power of collaboration. He predated the rise of social and collaborative learning way before the advent of the Internet as we know it today. This is because Vygotsky knew that learning was always accomplished socially, and it is maximized when we are listening and talking to peers possessing varying strengths and abilities, and not only in the presence of an

authoritative teacher. Vygotsky's theories also feed into current interest in collaborative learning, suggesting that group members should have different levels of ability so more advanced peers can help less advanced members operate within their zone of proximal development.

3.2 Social Interdependence Theory

Social interdependence theory which developed by Morton Deutsch assumes that the behavior of individuals in a group depends on the dependence of their goals [13]. Social interdependence theory has been carefully formulated to explain cooperative and competitive relations among individuals joined in a working or a learning group. Social interdependence refers to students' efforts to achieve, develop positive relationships, adjust psychologically, and show social competence. The essence of a group is the interdependence among members, which results in the group being a dynamic whole so that a change in the state of any member or subgroup changes the state of any other member or subgroup. Group members are made interdependent through common goals. As members perceive their common goals, a state of tension arises that motivates movement toward the accomplishment of the goals.

Social interdependence exists when the accomplishment of each individual's goals is affected by the actions of others. There are two types of social interdependence, positive (cooperation) and negative (competition) [10].

Positive interdependence exists when individuals perceive that they can reach their goals if and only if the other individuals with whom they are cooperatively linked also reach their goals and, therefore, promote each other's efforts to achieve the goals. Positive interdependence results in promotive interaction. Promotive interaction may be defined as individuals encouraging and facilitating each other's efforts to complete tasks, achieve, or produce in order to reach the group's goals as shown in Figure 2. It consists of a number of variables, including mutual help and assistance, exchange of needed resources, effective communication, mutual influence, trust, and constructive management of conflict.

Negative interdependence exists when individuals perceive that they can obtain their goals if and only if the other individuals with whom they are competitively linked fail to obtain their

goals and, therefore, obstruct each other's efforts to achieve the goals. Negative interdependence results in oppositional or contingent interaction.

No interdependence results in the absence of interaction in which individuals perceive that they can reach their goal regardless of whether other individuals in the situation attain or do not attain their goals.

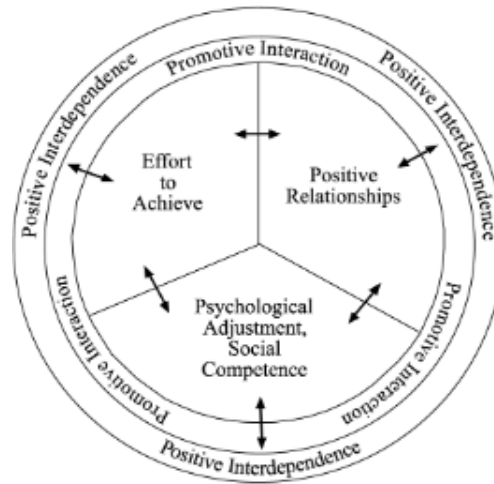


Figure 3.2: Social Positive Interdependence. [7]

The social interdependence perspective of collaborative learning presupposes that the way social interdependence is structured determines the way persons interact with each other. Moreover, outcomes are the consequence of persons' interactions. Therefore, one of the collaborative elements that have to be structured in the e-learning environment is positive interdependence or cooperation. When this is done, cooperation results in promotive interaction as group members encourage and ease each other's efforts to learn.

In collaborative learning, the development of interpersonal skills is as important as the learning itself. The development of social skills in group work-learning to cooperate is key to high quality group work. Many cooperative learning tasks are put to students with both academic objectives and social skills objectives. Many of the strategies involve assigning roles within each small group (such as recorder, participation encourager, summarizer) to ensure the positive interdependence of group participants and to enable students to practice different teamwork skills. Built into cooperative learning work is regular "group processing,"

a “debriefing” time where students reflect on how they are doing in order to learn how to become more effective in group learning settings [15].

Learner-learner social interaction in positive interdependence situation makes cooperative learning powerful. To accomplish the group’s goals, learners must exchange ideas, make plans, and propose solutions. Thinking through an idea and presenting it in a way that can be understood by others is intellectual work which promotes intellectual growth. The exchange of alternative ideas and viewpoints enhances that growth and stimulates broader thinking among the cooperative e-learning sessions. [40].

Cooperative learning and its underlying theoretical framework, social interdependence theory, can provide many insights into preparing joined learners to work with others to synthesize common goals and then attain common purposes, which are essential for developing collaborative advantage [24]. Social interdependence raise the effectiveness of collaborative learning by promoting individual and group accountability, face-to-face promotive interaction, teamwork skills, and group processing.

3.3 Cognitive Elaboration Perspective

Cognitive elaboration is a theoretical perspective in which collaborative learning is assumed to be effective because it requires participants to elaborate their cognitive structures in a social and interactive context [16]. Cognitive elaboration approaches to collaborative learning are based on information processing theory. Information processing theory suggests that performing these activities in the presence of peers will result in deeper processing and more active engagement with the tasks at hand. The presence of a peer can help learners stay on task, and the feedback provided by a peer can help students understand when they need to check their understanding of the content they are trying to explain [23] .

Research in cognitive psychology has long held that if information is to be retained in memory and related to information already in memory, the learner must engage in some sort of cognitive restructuring, or elaboration, of the material [29]. Peer interaction in learning activities based on cognitive elaboration is used to amplify individual performance of basic

information processing activities such as encoding, schema activation, rehearsal, meta-cognition and retrieval. In addition, cognitive elaboration in collaborative learning enhances student learning by providing a context in which individual learning is promoted by the use of more effective learning processes. In other words, an individual learns better with a peer because the peer provides an audience, prompts more meta-cognition, or maintains an individual's focus on a task.

One of the most effective means of applying elaboration in collaborative learning activities is explaining the material to someone else. This method has been successfully applied in writing process models [12] in which students work in peer response groups or form partnerships to help one another draft, revise, and edit compositions. In this method students take roles as recaller and listener. They read a section of text, and then the recaller summarizes the information while the listener corrects any errors, fills in any omitted material, and helps think of ways that both students can remember the main ideas. The students switch roles next time. Peer response groups have long found achievement benefits for the recaller as well as the listener.

Social interaction in collaborative learning stimulates elaboration of conceptual knowledge. In a collaborative learning situation, students will verbalize their understanding and the knowledge become more elaborated because communication implies that learner want to be understood by the other, which results in more coherent explanations. More ever, social interaction can emphasize the co-construction of knowledge through negotiation which aims to integrate different points of view [3]. Knowledge negotiation generates explanations, justifications, reflection and a search for new information.

3.4 Connectivism Learning Theory

Connectivism is a learning theory for the digital age proposed by George Siemens that recognizes the impact of technology on society and ways of how people live, communicate and how they learn. Connectivism provides a premise and a framework that are very useful for understanding collaborative learning in an online environment. From Siemens viewpoint, learning in the digital age is no longer dependent on individual knowledge acquisition,

storage, and retrieval; rather, it relies on the connected learning that occurs through interaction with various sources of knowledge (including the Internet and learning management systems) and participation in communities of common interest, social networks, and group tasks. In Connectivism, learning is a process that occurs based upon a variety of continuously shifting elements [17].

The starting point of learning is the individual who feeds information into the network, which feeds information back to individuals who in turn feed information back into the network as part of a cycle. Because there is so much information available in the connected network and the information is changing rapidly, it is very important at an individual level to be able to filter content to determine which information is valuable to the user. Not only does the individual have to filter content but it is also the belief that the new information can change thinking so that future decisions are based on the latest information. Connectivism presents itself as a pedagogical approach that affords learners the ability to connect to each other via social networking or collaboration tools.

Many theories assume that learning happens inside the head of an individual. Siemens believes that learning today is too complex to be processed in this way and that “we need to rely on a network of people (and, increasingly technology) to store, access, and retrieve knowledge and motivate its use” [17]. Learning is viewed as multi-faceted and particular tasks define which approach to learning is most appropriate to the learner.

From this perspective, learning consists of retrieving information from self, others, and machines, collaborating to create knowledge, and applying information to current contexts. Hence, Siemens learning theory is about individuals connecting with each other and with technology. Effective learners are those who can cope with complexity, contradictions, and large quantities of information, who seek out various sources of knowledge, and who can create and sustain learning communities and networks. According to Siemens, learning ecologies (communities and networks) facilitate important information sharing and co-

construction of knowledge while encouraging life-long learning in the individual as well as the group.

Connectivism learning theory outlines the following principles of collaborative e-learning as follows [17]:

- Learning and knowledge rests in diversity of opinions.
- Learning is a process of connecting specialized nodes or information sources.
- The ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.
- Decision-making itself is a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

Connectivism recognizes that in the online learning environment, seeking and constructing knowledge is most often accomplished through interaction and dialogue. Siemens notes that learner-learner interactions in an e-learning collaborative e-learning environment can be viewed as a four stage continuum:

- Communication : People ‘talking,’ discussing
- Collaboration: People sharing ideas and working together (occasionally sharing resources) in a loose environment
- Cooperation :People doing things together, but each with his or her own purpose
- Community: People striving for a common purpose.

This continuum of involvement provides a useful framework for thinking about scaffolding with learners through progressively more complex interaction skills leading to the creation of an effective working group.

In a collaborative learning environment, knowledge is shared or transmitted among learners as they work towards common learning goals, for example, a shared understanding of the

subject at hand or a solution to a problem. Learners are not passive receptacles but are active in their process of knowledge acquisition as they participate in discussions, search for information, and exchange opinions with their peers. Knowledge is co-created and shared among peers, not owned by one particular learner after obtaining it from the course materials or instructor. The learning process creates a bond between and among learners as their knowledge construction depends on each other's contribution to the discussion. Hence, collaborative learning processes assist students to develop higher order thinking skills and to achieve richer knowledge generation through shared goals, shared exploration, and a shared process of meaning making [25].

It is concluded up from the above four theories that the main difference between the traditional individual learning and collaborative learning is that the trainer/instructor centered model of traditional individual learning is replaced by a learner-centered model. Knowledge and skills in learner-centered model are delivered to the learners in a social and an interactive manner [28]. Learner-centered model is a self directed learning experience which provides several benefits to the learners including the potential for increased learning because of a greater feeling of ownership of the learning process, an increased responsibility for participating in the learning process, an expanded ability to use a variety of techniques to achieve learning goals, and an enhanced ability to present ideas in a wider variety of forms. The employment of self-directed learning approaches also provide several benefits to instructors including greater freedom to explore material, increased satisfaction because of students having more effective learning experience, and decreased teaching effort as the student takes on greater responsibility for learning.

Researchers showed that collaborative learning promotes learners to a higher level of achievement compared to individual learning. Collaborative learning offers many cognitive advantages to learners [12]. Moreover collaborative learning increases the learners' problem-solving abilities [18]. As empirical studies show collaborative learning is efficient and enhances cognitive skills, soft skills and the self-esteem of the learners [29].

Chapter 4

The Proposed Collaborative e-Learning Model

This chapter presents a proposed collaborative e-learning model based on the four social cognitive development theories which were explained in chapter 3. The model tasks are introduced as well as the requirements specification, analysis and design of these tasks.

4.1 The Proposed Collaborative e-Learning Model

Collaboration in E-learning has its roots in social and cognitive development theories. Building Collaborative e-learning environments highly requires the integration of pedagogical perspective as well as technical perspective. Figure 3 illustrates an integrated a proposed model of collaborative e-learning based on four social cognitive development theories which discussed previously in chapter 3. The collaborative e-learning model has six levels which are: *Networking, Contribution, Cognitive Disequilibrium, Origination of Social Interaction, Knowledge Evolving, and Cognitive Equilibrium*. The arrangement of these levels ensures the logical sequence of social and cognitive processes that are occurred during collaborative e-learning. The scope of this model is about how the joined learners will learn not what they will learn.

The proposed collaborative e-learning model serves as coherent and integrated foundation that can be utilized as a guidance to design and develop Web-Based collaborative e-learning environments. Well designed and well developed collaborative e-learning environments provide space for knowledge building and promote group connectivity and collaboration experiences that help learners to acquire the skills necessary to create and effectively participate in learning communities and social networks. Through successful collaborative activities and knowledge sharing individual cognitive capacities can be enlarged and cognitive load shared.

According to the proposed collaborative e-learning model, networking level is the necessary first step for collaborative e-learning since the creation of mutually shared cognition requires forming a sense of learning community and the existence of joined online learners. Connectivism theory emphasizes the online learning community as a basic element to bring collaboration to e-learning systems.

The successful formation of an online learning community motivates the joined learners to contribute to the all community as they are in face- to face meetings. Their contribution is established and transmitted through the online community. From a cognitive perspective, learner's contributions which are learner based knowledge feeding expected to cause a cognitive disequilibrium on the mind of the knowledge receivers. Being in disequilibrium cognitive situation the learner is motivated to reflect its own personality in learning process.

The social interactivity of the learners is promoted through social dialogue which is embedded with high and intensive interaction with different models such as written feedback and audible and visual discussions. Through the social interaction the knowledge is evolved and accumulated as the learners build and conceptualize that knowledge collaboratively. The online learning community became a rich space of sharing information and experiences among the community members which enables members to learn from each other. The result from this social interaction is a co-constructed knowledge that emerges from collaboration. The co-constructed knowledge represents a cognitive change or conceptual change on the learners mind which describe an equilibrium situation that achieved by knowledge accommodation.

The collaborative e-learning model comprises three core concepts namely: interactivity, social context and technology. These concepts are the foundation for an effective collaborative knowledge acquisition and exchange in e-learning environments. Interactivity is the process that enables the learner to actively and effectively engage with his colleagues to accomplish a specific task [34].

Interactivity results in deeper learning because learners experience what they learned; reflect on the information and grasp the knowledge being taught [9] . It helps grab the learner's

attention, retain learner's interest, transfer information better and acts as an aid to retention [20]. Interactivity is the magic element that makes e-learning both engaging and effective. The social context in e-learning reflects how the learners use and interpret a learning subject. It shows how knowledge is viewed and how it influences others [26]. It requires taking into account the role of communication and conversation in the learning process.

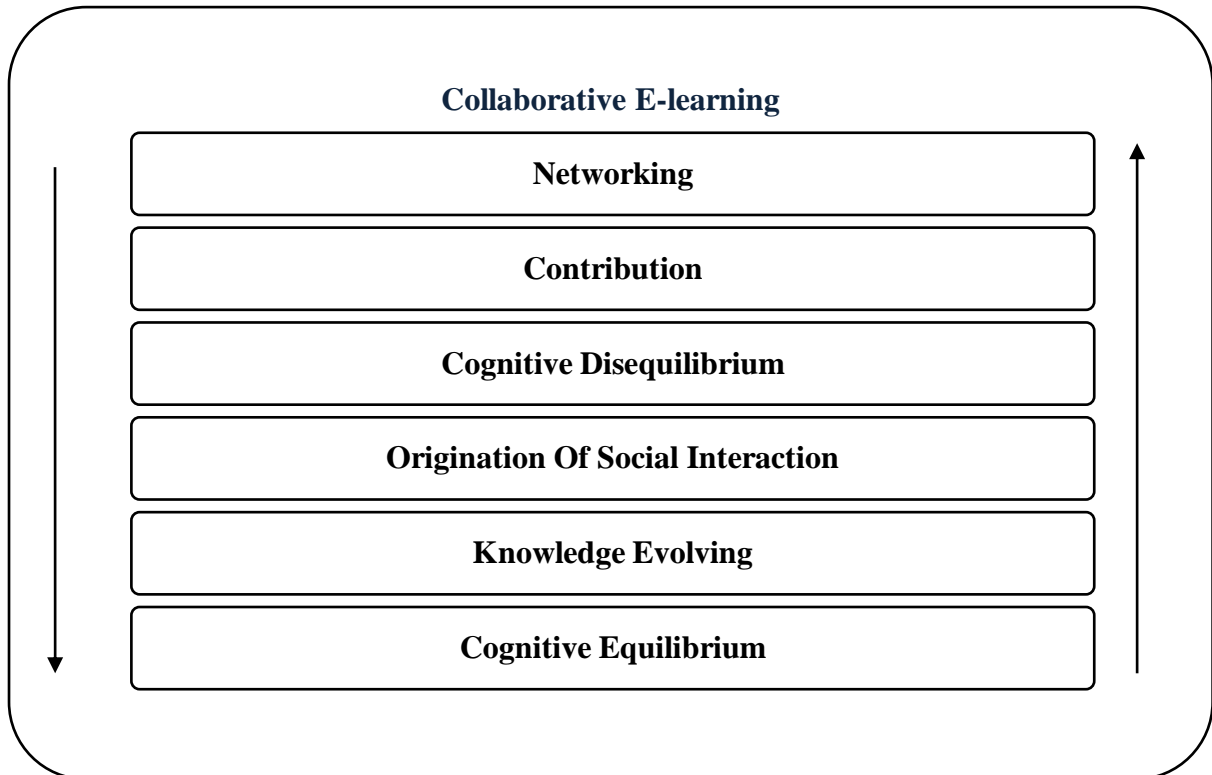


Figure 4.1: Collaborative e-Learning Model

Learners who are engaged in social learning sessions receive strengthened, reinforced, and refined learning. Interactivity and social context are guaranteed to be achieved if a supportive technology is utilized to provide learners with high level tools for group communication and group activities. Integrating the three concepts in collaborative e-learning systems has implications on the analysis, the design and the implementation of such system.

4.2 The Proposed Collaborative e-Learning Model Tasks

In collaborative e-learning environments, learners can be represented by connected nodes and act as information resources. The core of the collaborative e-learning process is the knowledge exchange and information transfer between these nodes. Figure 4 illustrates the six tasks of the proposed collaborative e-learning model which specify how to acquire and exchange knowledge collaboratively in e-learning environments.

The six tasks of the model are: *Knowledge Feeding*, *Knowledge Self-Reflection*, *Knowledge Negotiation*, *Knowledge Elaboration*, *Knowledge Accommodation* and *Knowledge Shifting*. The model tasks can be originated and occurred in a bidirectional order. This allows the learners interaction and knowledge exchange to be done in flexible way and according to the cognitive level of the learners. It is also important to mention that the model tasks are interrelated such that one task can include other tasks.

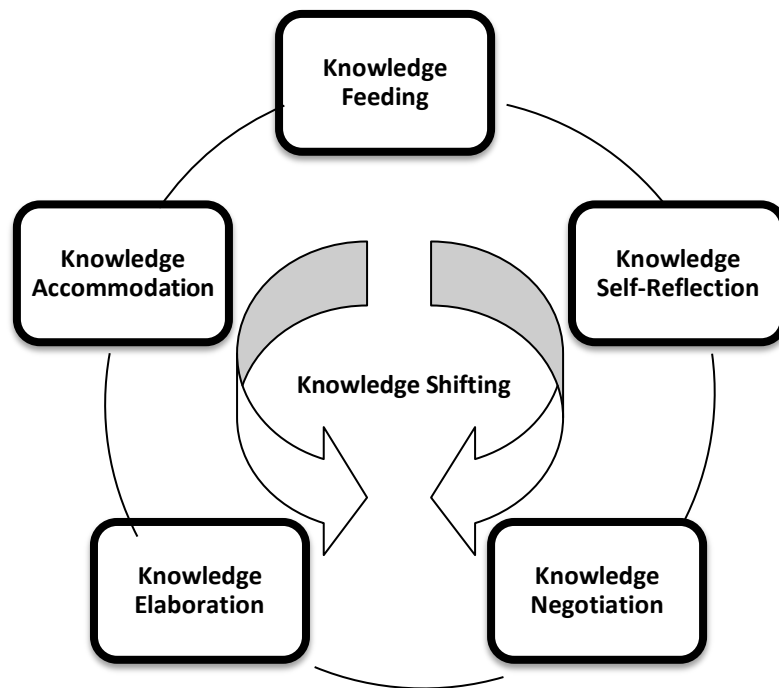


Figure 4.2: Collaborative e-Learning Model Tasks

4.3 Requirements Specification of the Collaborative e-Learning Model Tasks

The proposed collaborative e-learning model is based on and heavily aligned with the four cognitive development theories that were explained in chapter 3.

Each task in the proposed collaborative e learning model is a separated task with its own requirements. The requirements of every task is specified and verified according to the underlying pedagogical and technological foundations for the model. The Integration and the interdependence among the model tasks constitute a powerful and a coherent collaborative e-learning model. The requirements specification of the proposed collaborative e-learning model tasks includes the following:

4.3.1 Knowledge Feeding

This task is responsible for initiating the collaborative learning session. It requires the availability of an electronic shared space. This shared space can be accessible and reachable by all the joined learners. The learners are able to feed any kind of knowledge into the shared space which is related to a certain learning subject. This requires that the knowledge which has been fed into the shared space is:

- Dated with contributor identity enabled (the identity (ID through the network) of who fed this knowledge is clear (no option for anonymous contribution))
- Visible and available: The knowledge which is fed into the shared space can be seen and accessed by all the joined learners in the shared space.
- Mutli-type (text, image, audio, video, URL)

4.3.2 Knowledge Self-Reflection

During this task learners are encouraged to express and share their ideas, their insights, their view points and their feedback that originated as a mutli-type written response about the fed knowledge. The learners are able to comment on others knowledge feeds as well as track all the comments associated with any knowledge feed.

4.3.3 Knowledge Negotiation

Knowledge negotiation task is a primarily social task through which the social context concept starting to be realized and achieved in the collaborative e-learning environment. It requires the availability of different group communication tools such as:

- Instant messages (IM).
- Email messages.
- Audio chat.
- Video chat.

4.3.4 Knowledge Elaboration

This task is the complement for the previous task where the social context is upgraded to its highest level. It enables learners to construct knowledge collaboratively and share their understanding with others. Knowledge elaboration requires the availability of group activities tools like:

- Existence of public white board supported with a rich tool box.
- Existence of sharable text editor with multi-user editing.
- Ability of sharing recourses (desktop screen, docs, presentations, sheets, PDF, images, Web page).

4.3.5 Knowledge Accommodation

Knowledge accommodation is the responsible task for sustaining the impact of collaborative e-learning. Learners are able to save and reuse what they learned. It requires the existence of:

- A shared and personal library of the knowledge produced objects (docs, presentations, sheets and screen shots)
- Recording for the overall online learning session.

4.3.6 Knowledge Shifting

This task ensures the knowledge flow and exchange among the joined learners through the collaborative e-learning tasks. It controls how learner's interactions are achieved in the

learning session. Knowledge shifting is a bi-directional knowledge transition where learners can move from one task to another in ordered or non ordered manner.

4.4 Design of the Collaborative e-Learning Model Tasks

The requirements of collaborative e-learning model tasks which specified and analyzed previously are assembled in a basic design as illustrated in Figure 4.3. This design serves as technical skeleton that draws and organizes the integration between the six tasks of the collaborative e-learning model. It is worth to mention that this design is aligned with the three main concepts of effective collaborative e-learning namely: interactivity, social context and technology. A collaborative e-learning scenario is simulated in order to build this design. The advantage of a simulated collaborative e-learning scenario is to verify the feasibility and the usability of using the collaborative e-learning model to build actual online collaborative e-learning environments [8].

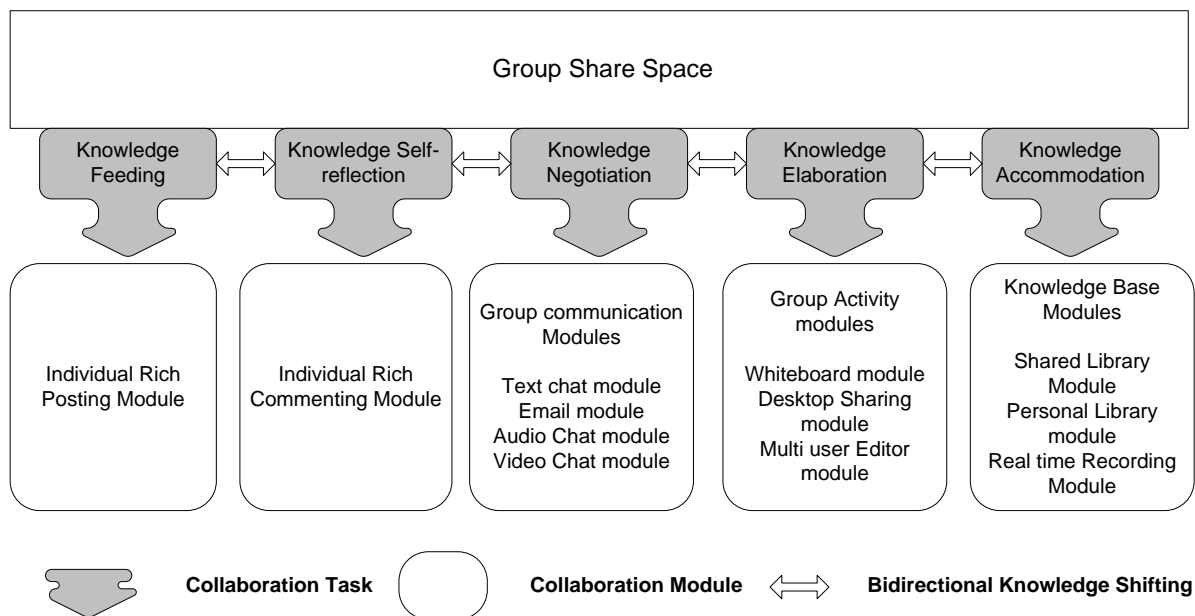


Figure 4.3: Design of Collaborative e-Learning Model Tasks

The collaborative e-learning scenario can be summarized as: *“Group of learners are enrolled in a traditional classroom in which they just receiving the knowledge from their teacher, after*

classroom hours they have the ability to be joined together in an online space in which they can discuss what they learned in the classroom, each one of them can post any kind of knowledge, the others updated with what he posted and are motivated to comment on his post, as a result he can track all the comments on his own post as well as commenting on others posts ,the presence of each learner can be shown in the online space so the others can be informed who are available in the online space, according to the availability of the joined learners in the online space a social dialogue can be occurred about any knowledge was posted , the joined learners can start a video or audio conversations to discuss and share their ideas about the posted knowledge, for more understanding and perception they may need to construct and explain a piece of knowledge collaboratively so they can share their screens or programs or even co-author a document together, the learners wish to maintain their understanding and reuse it later by storing learning documents in a shared or personal library as well as recording the overall learning session”

According to the previous collaborative e-learning scenario, the design of the collaborative e-learning model consists of interrelated modules that represent the model tasks. First of all, there is a group shared space which is an electronic virtual space. It enables the learners to be joined online. This online shared group space is equipped with various collaborative modules as follows:

- **Individual rich posting module:** this module enables the joined learners to post what is in their mind about a certain learning subject. They can feed any type of knowledge they wish to share with other learners. The post will be published with its actual date and time and can be accessed and viewed by all the joined learners. This module is related with *Knowledge Feeding* task.
- **Individual rich commenting module:** this module enables the joined learners to express their view points and their opinions about any published post. All the joined learners can comment and track the others comments. This module is a realization of *Knowledge Self-Reflection* task.
- **Group communication module:** this module helps the learners to be engaged in real time audio and video conversation to conduct a verbal and written discussion about the

learning subject. They can chat with each other, send emails and talk together in real time.

This module is a realization of *Knowledge Negotiation* task.

- **Group activity module:** through the different tools of group activities, this module gives the learners the ability to construct new knowledge and raise their understanding about a learning subject. They can share their desktop screen, any program; office documents and co author any type of documents. This module is a realization of *Knowledge Elaboration* task.
- **Knowledge base module:** this module enable learners to save and store the produced learning objects in a personal and shared library, also they will be able to record the overall learning session and save it as video file in their machines for further reuse. This module is a realization of *Knowledge Accommodation* task.
- **Bi directional shifting module:** this module ensures the knowledge movement, growth and evolution through the collaborative leaning session. This module is a realization of *Knowledge Shifting* task.

The two main actors in the proposed collaborative e-learning environment are the instructor and the learner. The instructor is responsible for designing and creating the group shared space as shown in Figure 4.4. He can add learners, add courses, manage posted knowledge and manage library documents. Figure 4.5 shows the collaborative e-learning features which provided to be used by learner after a successful login he can post a new knowledge to the group shared space, comment on a posted knowledge, edit posted knowledge, add course, add library document, edit library document, join audio, video and whiteboard session and record audio, video and whiteboard session.

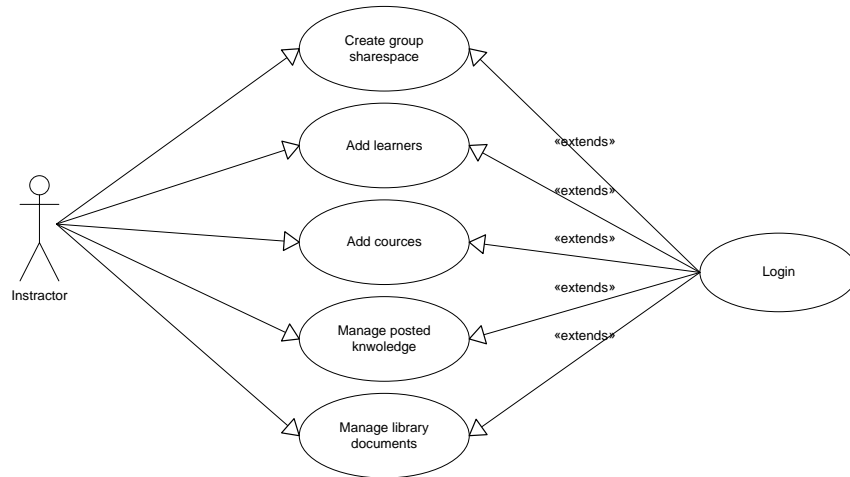


Figure 4.4: Instructor role in the collaborative e-learning environment



Figure 4.5: Learner role in the collaborative e-learning environment

Chapter 5

ShareSpace: A Realization of the Proposed Collaborative e-Learning Model

In this chapter a collaborative e-learning environment called ShareSpace which is a realization of the proposed collaborative e-learning model is presented. First, the technical infrastructure of the ShareSpace is stated, and then the social collaborative e-learning features of ShareSpace are introduced.

5.1 Technical Infrastructure of ShareSpace

There are various Web technologies either commercial or open source which can be utilized, customized and integrated in the educational systems of enterprises, universities and schools in order to make these systems more interactive, social, personalized and accessible.

Web (video and audio) conference and chat rooms raise the interactivity of collaborative e-learning environments and enhance the peer interaction among learners. Web conferencing enables educators, trainers, and learners to see, interact, and sometimes share a desktop, file, or application on a presenter's computer. Web 2.0 technologies bring the socialism, active participation, cooperation and bidirectional communication to the collaborative e-learning environment by allowing the learners to be involved in an on line learning communities and form learning groups.

User Generated Content (UGC) is one of the basic Web 2.0 tools which provide easy publication of new contents by the learners and sharing this content with learning community. The semantic Web and artificial intelligence technologies help in modeling the learner and offer a personalized learning to him according to his preferences, learning style and his mental ability. Cloud and distributed computing break the accessibility and technical infrastructure limitations which affect the implementations of many software's and applications by offering software as a service concept.

ShareSpace is developed based on SharePoint which is a cloud Web application platform developed by Microsoft [5]. SharePoint comprises a multipurpose set of Web technologies

that can be utilized for building collaborative and social Web environments. The successful adoption of Web 2.0 tools and Cloud-Based Collaborative Services (CBCS) in SharePoint platform raises its technical visibility to be a solid social learning platform.

ShareSpace is developed as a Web environment which integrates five cloud-based collaborative services namely: SharePoint collaborative Workspace, Portal Service, MS Office Web Apps, MS Lync Online and Integrated Outlook Email as illustrated in Figure 5.1.

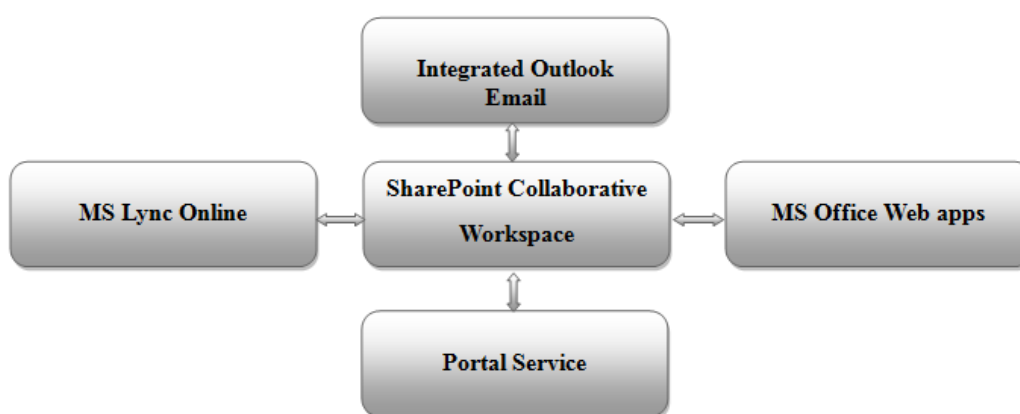


Figure 5.1: ShareSpace Cloud-Based Collaborative Services

The integration of the above five cloud based collaborative services offer a comprehensive infrastructure for social collaborative environments. Table 5.1 presents the implications for each cloud based collaborative service in the ShareSpace development.

Table 5.1: Implications for CBCS in ShareSpace Development

CBCS	Functional Description	Functional role
Portal Service	Facilitates and control the access to the collaborative workspace site, email and document libraries	An assistant service which enable learners to join the social collaborative environment
SharePoint collaborative Workspace	Acts as a digital group space which enables the joined learners to organize a collaborative knowledge sharing and	Provides the ability for sharing information and working together in teams, communities, and people-

	construction	driven processes. It is powered with many Web 2.0 tools such as: UGC, social tagging and social bookmarking.
MS Office Web Apps	Web-based versions of Microsoft Word, Microsoft Excel, Microsoft PowerPoint, and Microsoft OneNote	Allow joined learners to access their documents directly from anywhere within a Web browser as well as share files and collaborate on documents with their colleagues online
MS Lync Online	It is a cloud communications service that connects the learners anytime, from anywhere by intuitive communications capabilities	Provide real time presence ,instant messaging, sharing and collaboration, peer-to-peer voice and video calling, and online meetings
Integrated Outlook Email	A Web-based e-mail service	Enable learners to compos email , sending email, receive email, manage a calendar, and connect to people

5.2 ShareSpace Social Collaborative e-Learning Features

ShareSpace is powered with many learner-centered features which bring the sociability and interactivity to the e-learning experience. Figure 5.2 shows the shared group space which a learner can join and log-in to be engaged in a collaborative e-learning community. The group share space acts as the learning group wall. It is the space in which the learner can feed and post any kind of knowledge under a certain category (course).

The screenshot shows the ShareSpace Group Space interface. At the top, there is a navigation bar with 'Site Actions' and 'Browse' options, and the user name 'najwa baraka'. Below this is a header section with the 'Share Space' logo and name. A search bar is located on the right side of the header. The main content area is divided into several sections: a 'Categories' sidebar on the left, a 'Welcome to ShareSpace' message, a large 'ShareSpace A Social Collaborative E-learning Space' logo, and a 'ShareSpace Knowledge Feeds' section. The knowledge feeds section contains a table with the following data:

Title	Information Security Attributes NEW
Created By	najwa baraka
Published	9/4/2012 5:08 PM
Category	Information Security
# Comments	0

Figure 5.2: ShareSpace Group Space

Figure 5.3 shows how a new category (course) can be added.

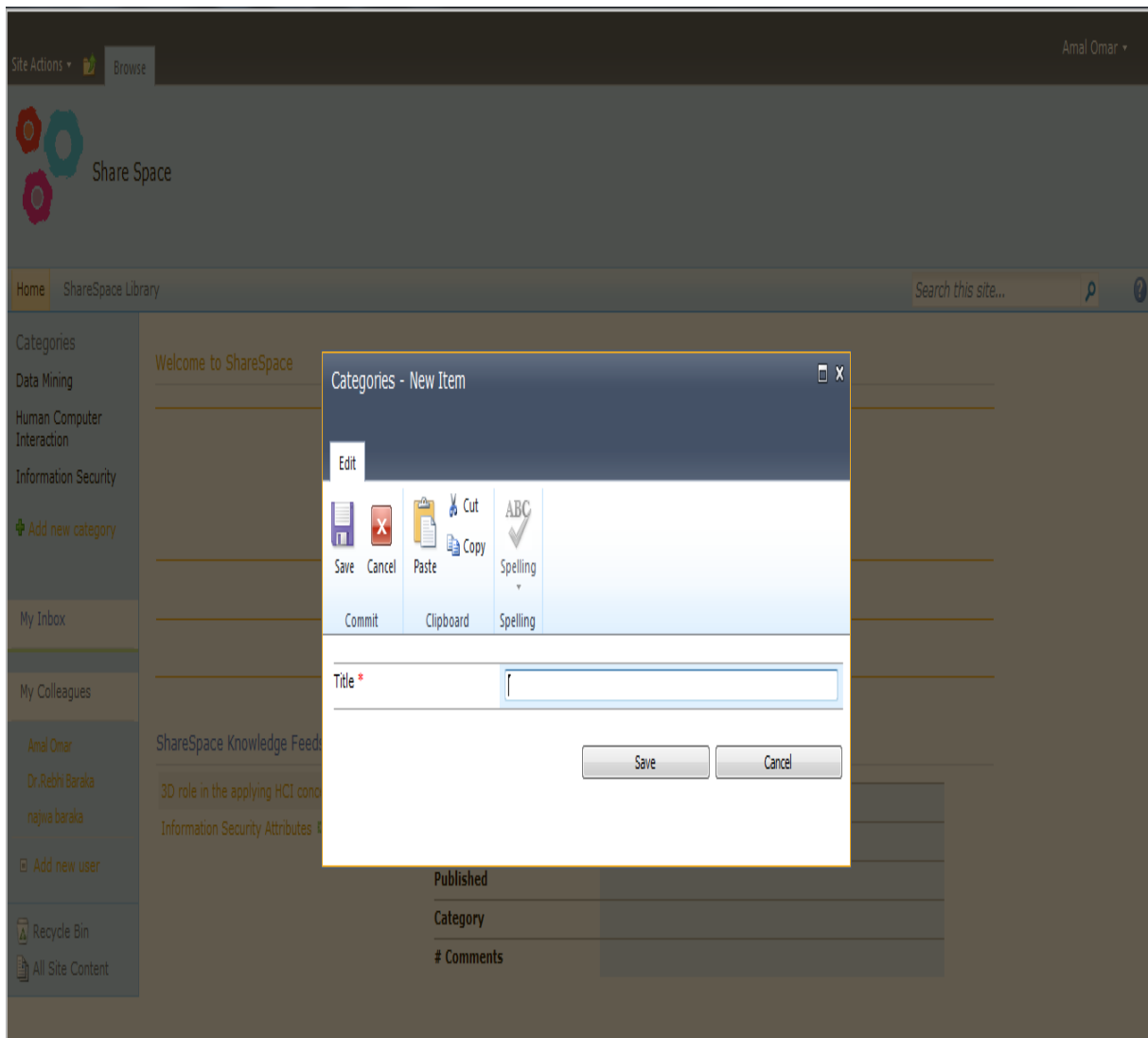


Figure 5.3: Adding New Learning Subject

Figure 5.4 presents the ability feeding new knowledge under a certain category. Posting and feeding knowledge are a realization of knowledge feeding task.

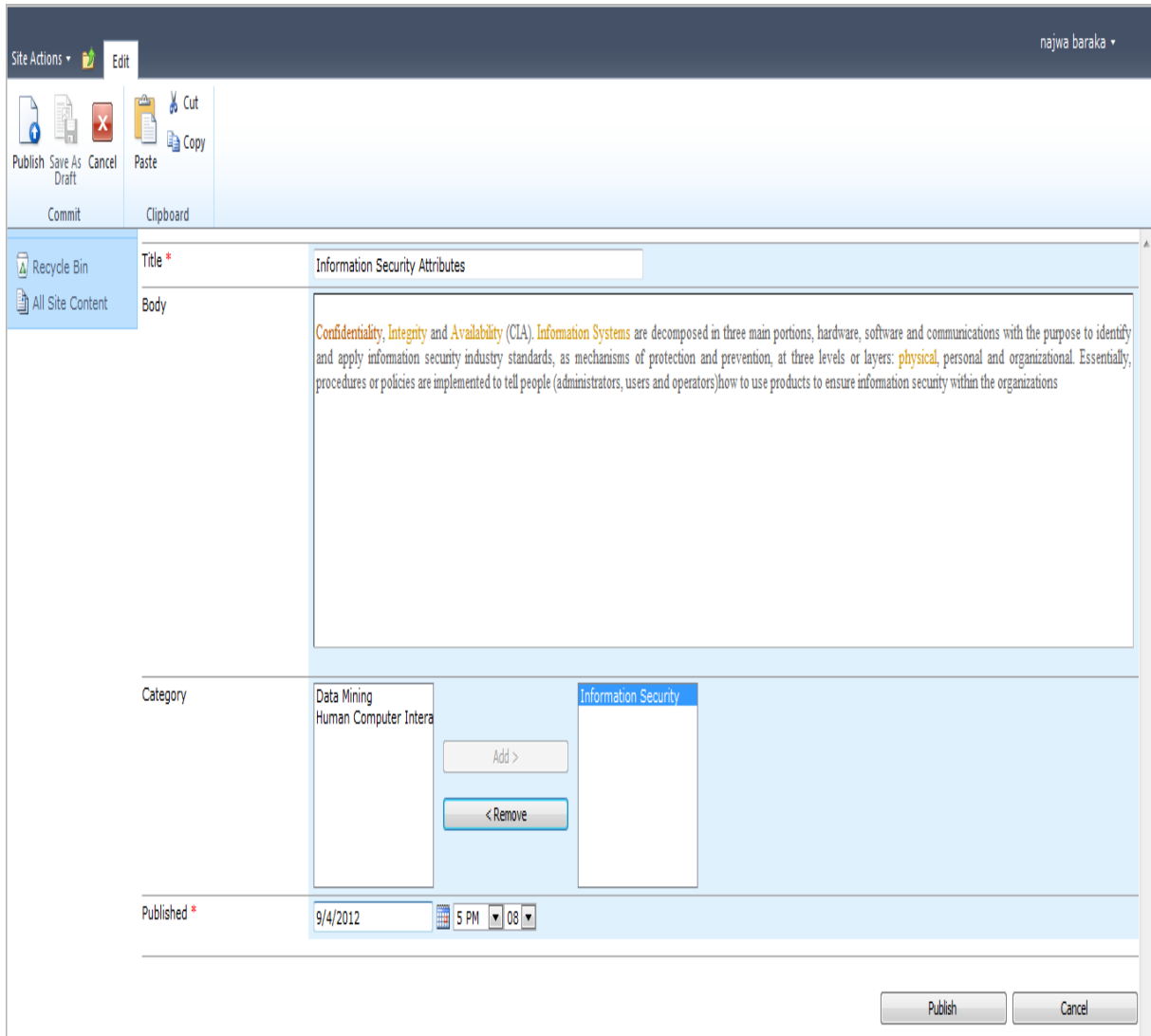


Figure 5.4: Feeding New Knowledge into SharePoint

As soon as the new knowledge is fed and posted into the group wall, all the joined learners are updated by this knowledge with all its relevant information like: post date, posted by and under which category. The self- reflection task is achieved by the ability of any member to comment and reply to the posted knowledge as Figure 5.5 presents. Learners can be engaged in a deep discussion about a certain learning topic through sequence of mutli-type written comments.

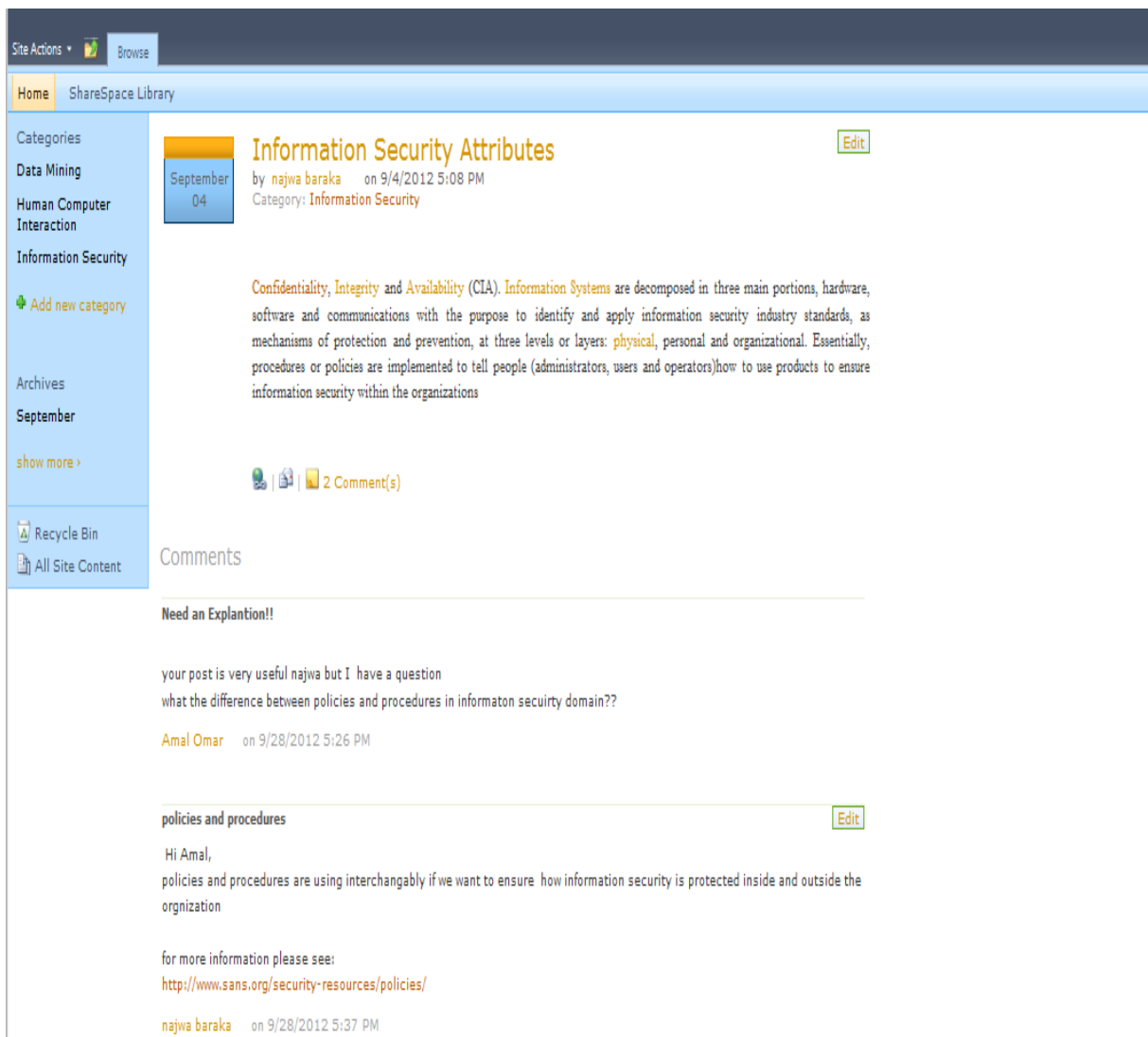


Figure 5.5: Commenting Feature in ShareSpace

Figure 5.6 presents the availability of a shared group library and a personal library. Shared group library is a container of all the files that were uploaded and shared by the joined learners. Personal library contains the files which was shared and uploaded by a certain member.

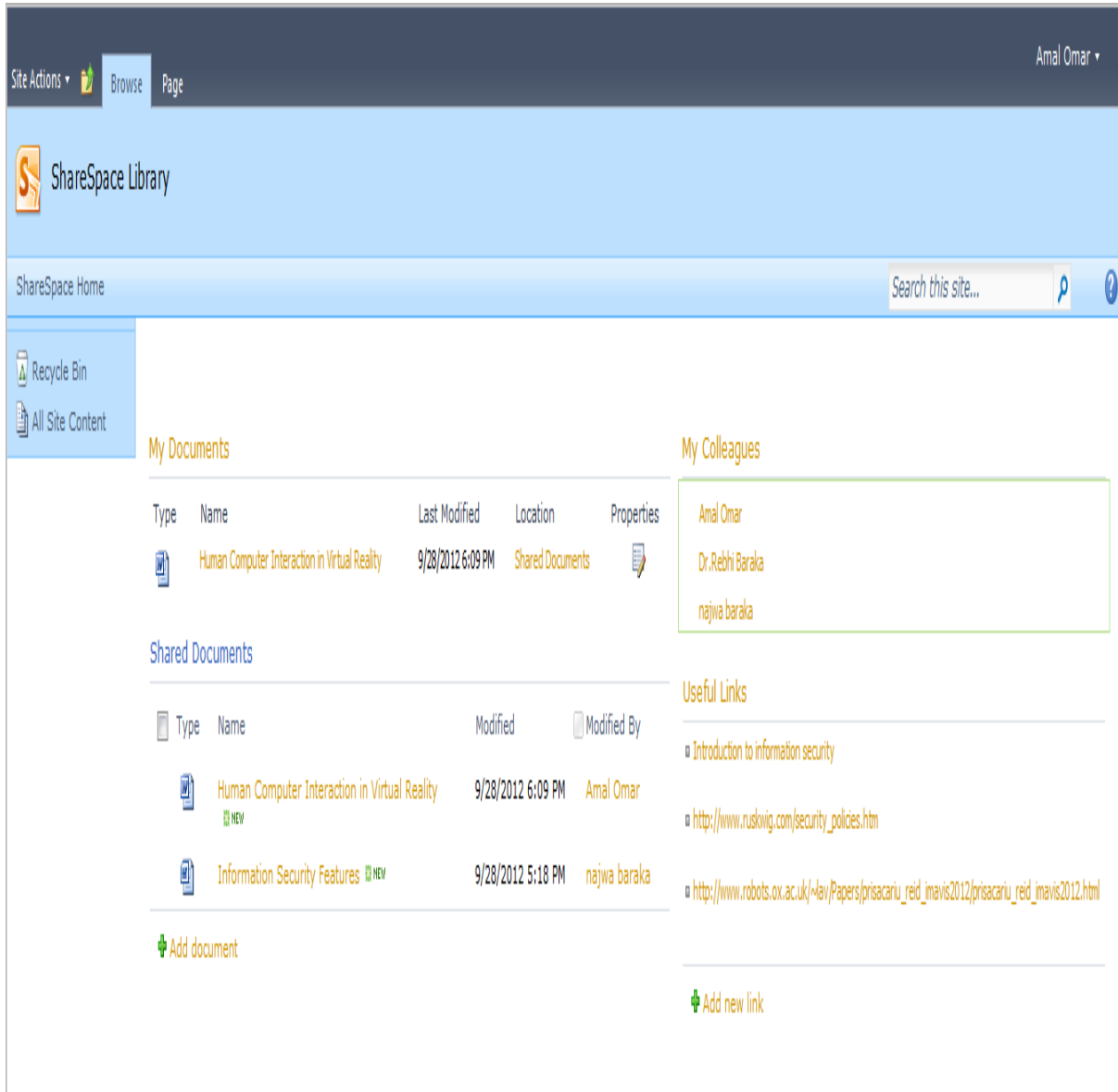


Figure 5.6: ShareSpace Group and Personal Library

Figure 5.7 demonstrates how a file can be uploaded to the group or to the personal library.

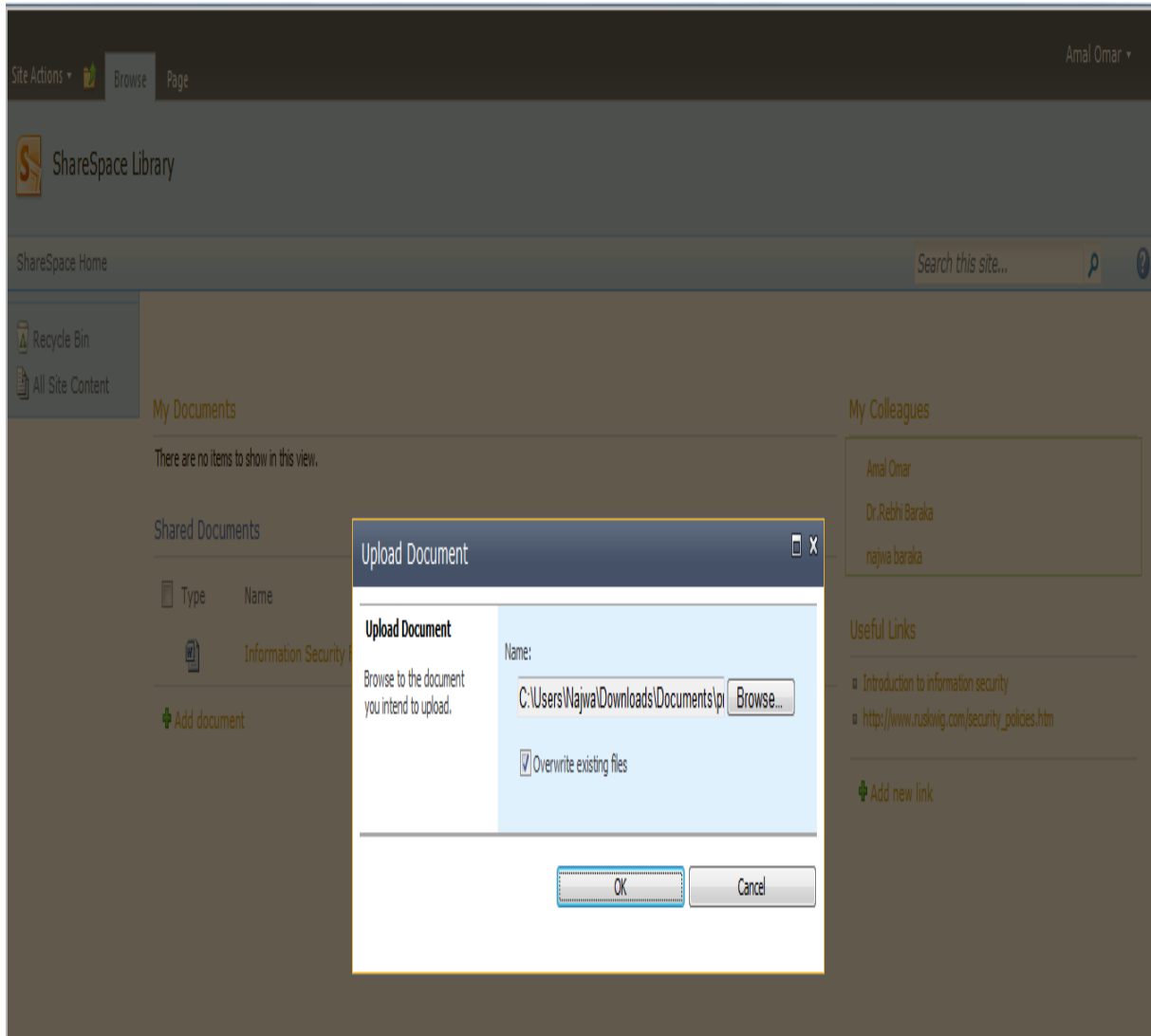


Figure 5.7: Uploading File into ShareSpace Library

Figure 5.8 presents the ability of co-editing a file collaboratively online. Both the group and personal library serves the realization of knowledge feeding task and knowledge accommodation task as well.

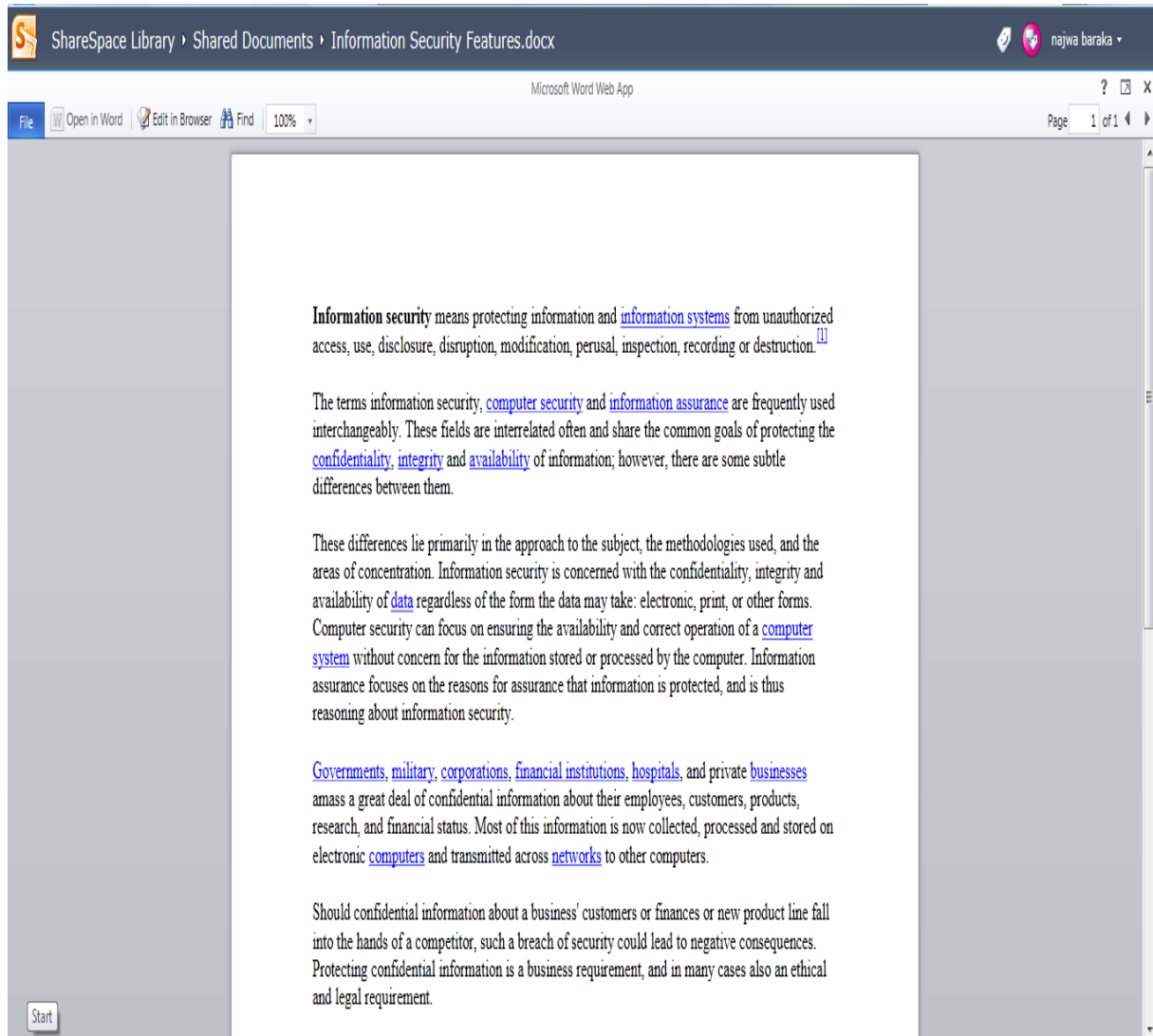


Figure 5.8: Editing File Online Feature

Joined learners can communicate together easily through many communication channels. Figure 5.9 shows how learners can use email to connect with each other. The email feature is a complete email service which allows the joined learner to compose, send, receive and keep contacts. Email feature can serve knowledge negotiation task, knowledge elaboration and knowledge accommodation but in personal level which is may be suitable for some learning situations.

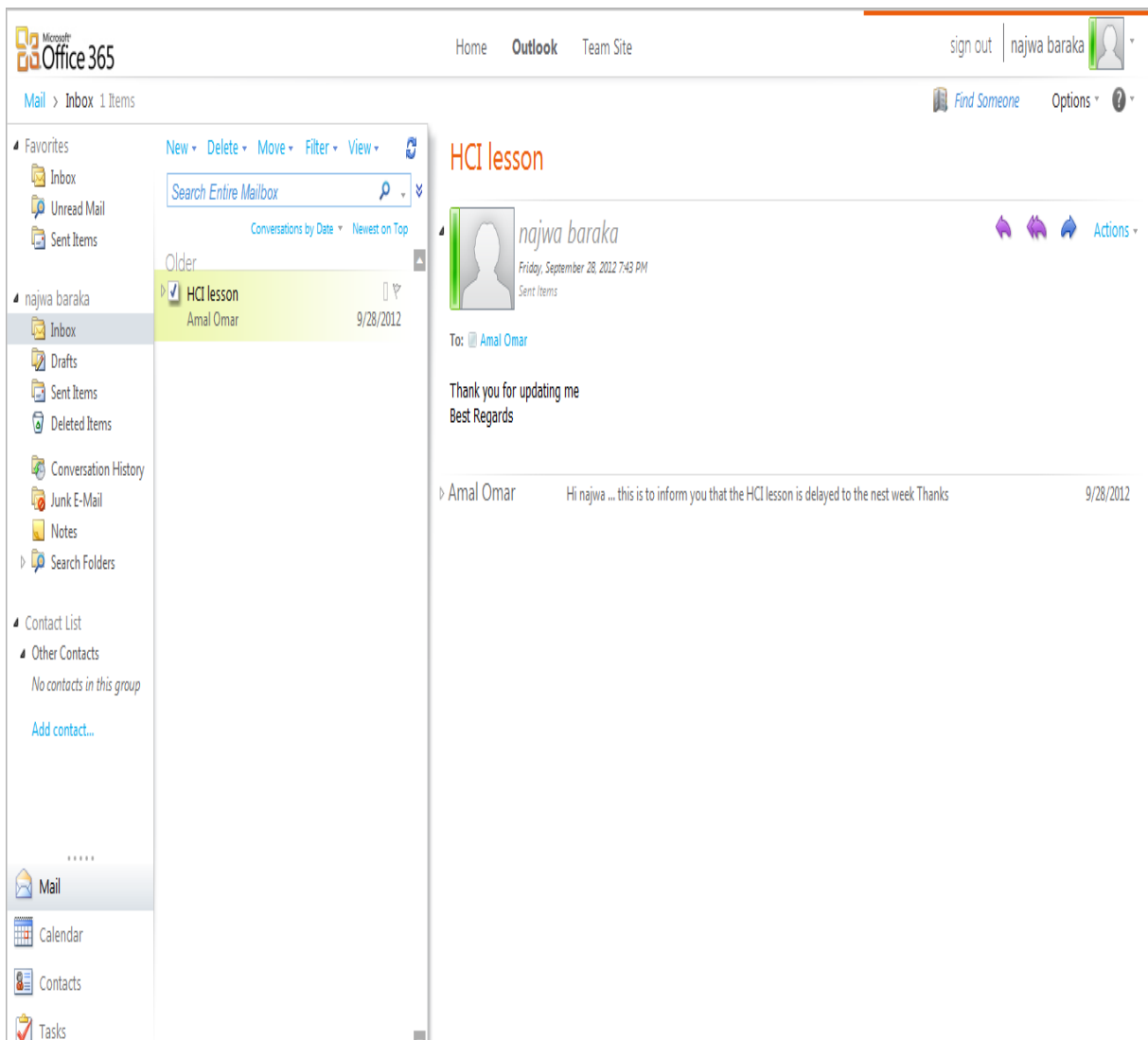


Figure 5.9: ShareSpace Email Feature

ShareSpace provides high level of sociability by providing the real time online presence of the joined learners. The real time online presence is the basic element of forming an online community which simlaute the face to face meetings. Figure 5.10 presents the real time presence of the which enable the joined learners to join an online real time socail and interactive learning sessions as if they are in a real classroom. The real time presence help in the realization of knowledge negotation task and knowledge elaboration task.

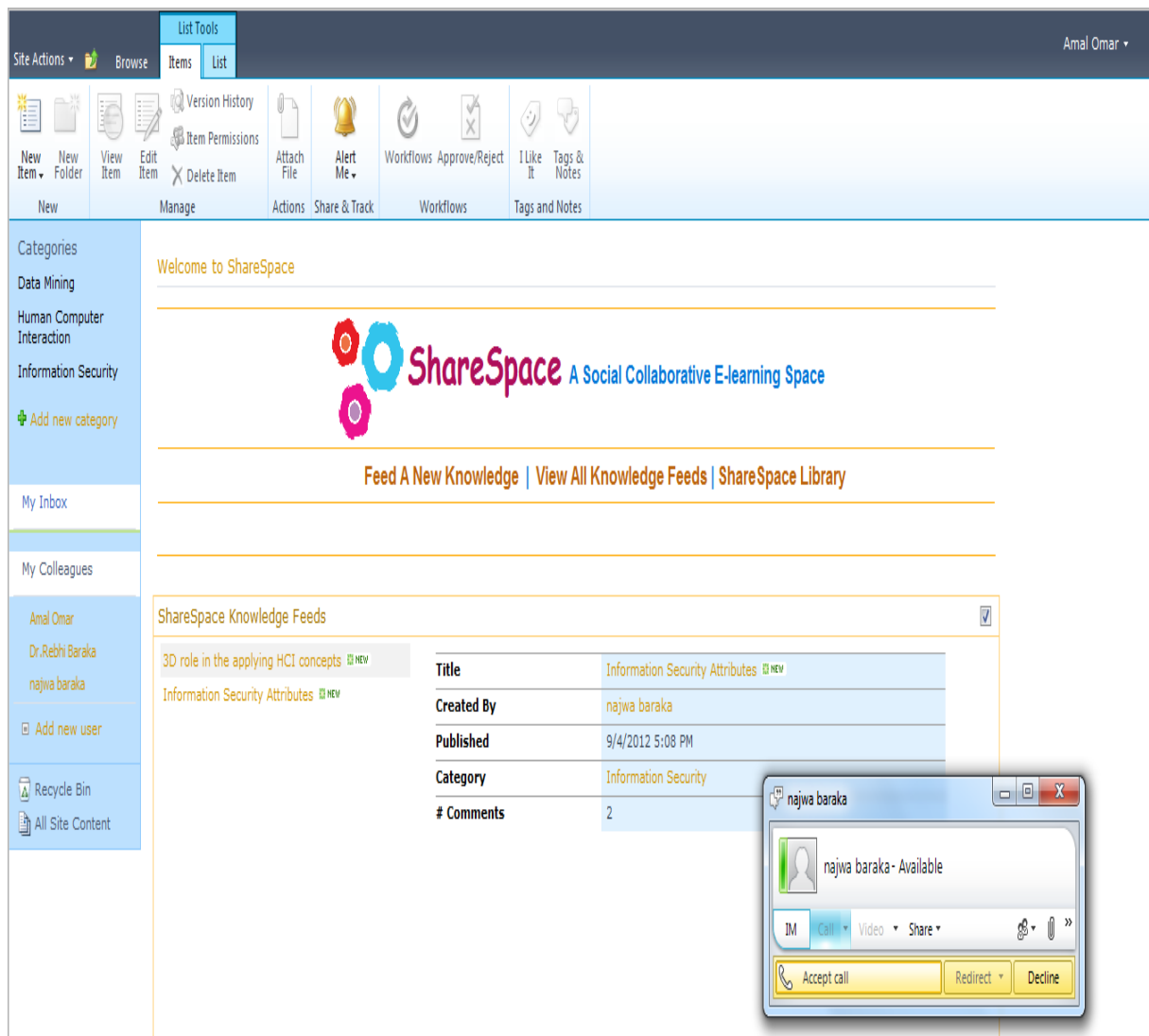


Figure 5.10: Real Time Presence of ShareSpace Members

Figure 5.11 demonstrates the availability of a group whitboard which serve as digital whitboard for the joined members to present or discuss a learning topic.

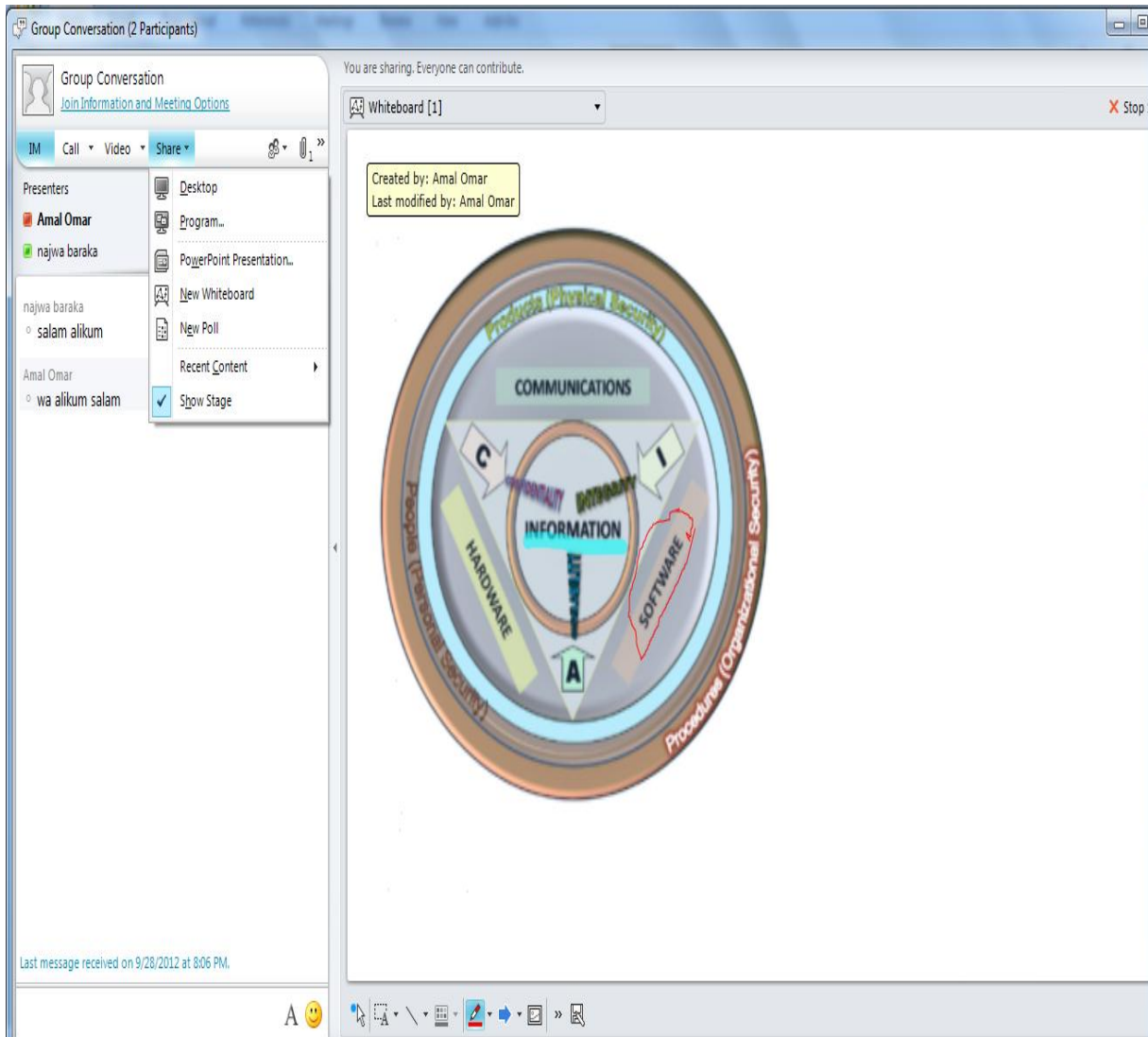


Figure 5.11: ShareSpace Group Whiteboard

The group whiteboard is enabled with draw and pointing tools and file sharing feature as shown in Figure 5.12.

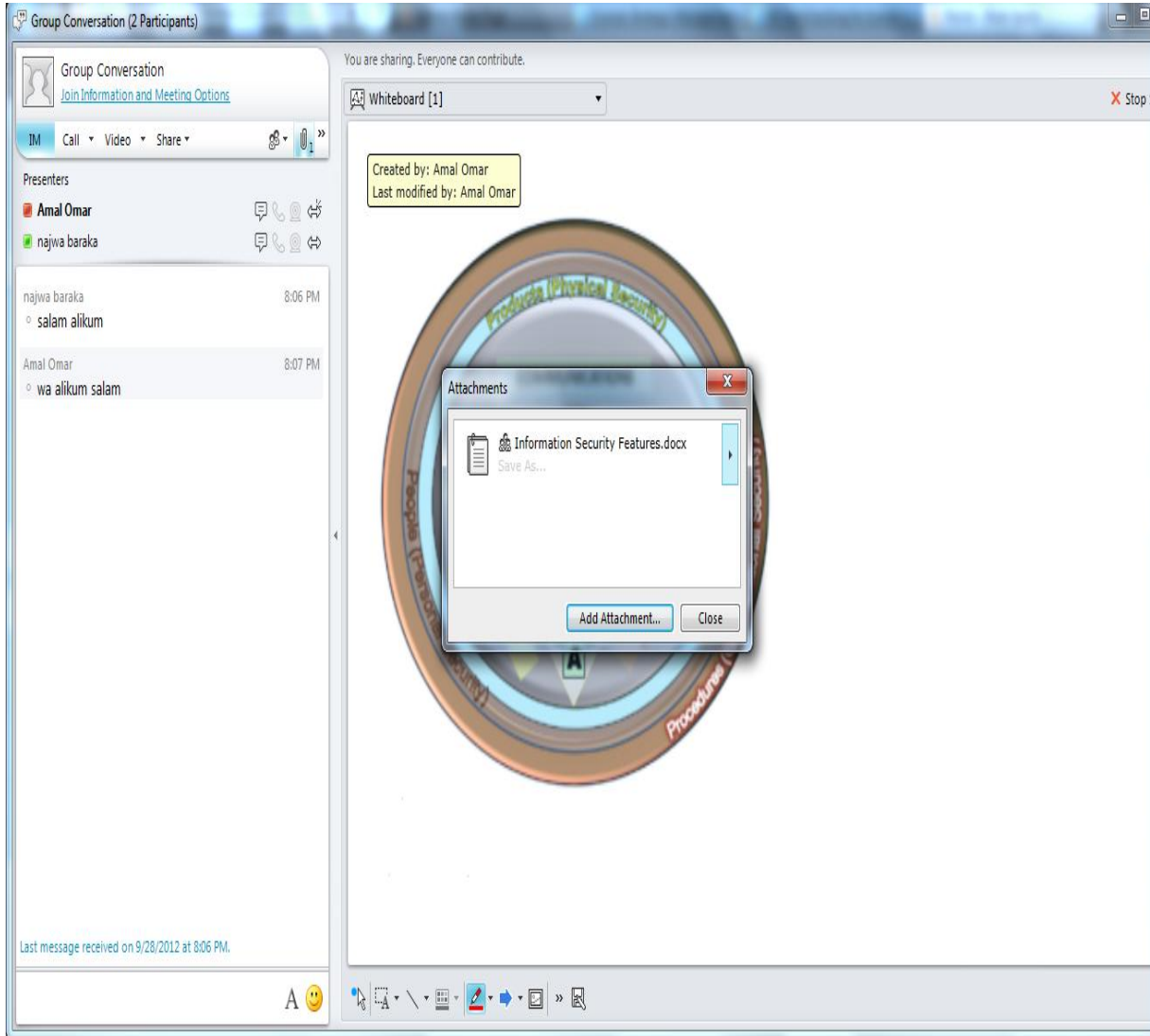


Figure 5.12: ShareSpace File Sharing Feature

In addition to the availability of the whiteboard the joined learners can use a text and video chatting in order to be engaged in interactive learning sessions as presented in Figure 5.13. The whiteboard, file sharing, text chatting and video chatting help in the realization of knowledge negotiation task and knowledge elaboration task. As for knowledge accommodation, learners can record the real time conversation and save it for later use. Also, he can keep the files which were shared through the real time learning session.

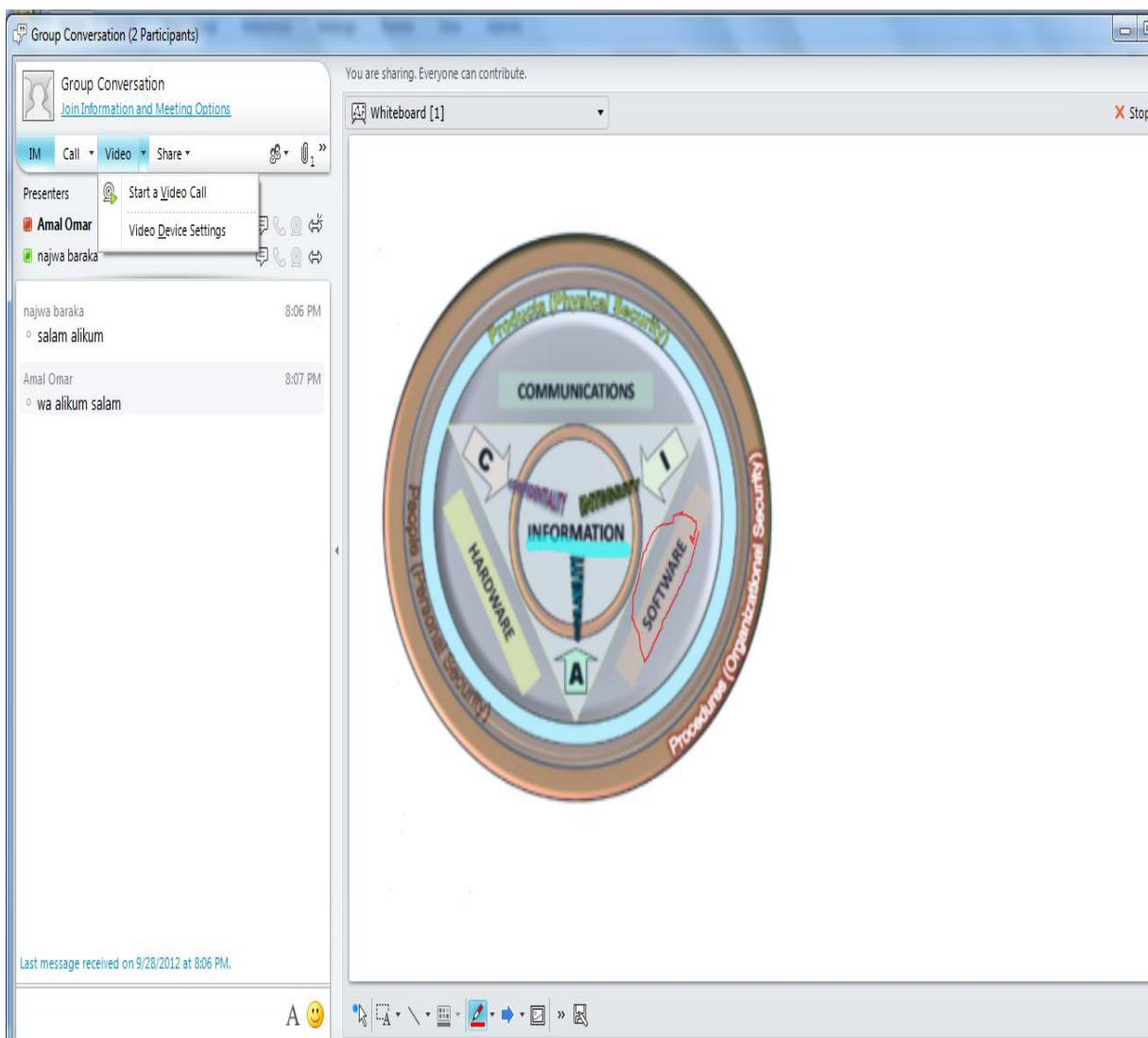


Figure 5.13: ShareSpace Text and Video Chatting

Chapter 6

ShareSpace Evaluation

This chapter presents the evaluation of ShareSpace. The evaluation will be conducted based on the collaborative e-learning model which was presented in chapter 4, on a framework for evaluating computer supported collaborative learning and on an adaptable usability heuristic checklist for online courses.

6.1 ShareSpace Evaluation against the Collaborative e-Learning Model

The collaborative e-learning model which was presented in Chapter 3 integrates various theoretical social cognitive perspectives for collaborative e-learning. The proposed collaborative e-learning model is too much aligned with the six levels of the collaborative e-learning model which are: *Networking*, *Contribution*, *Cognitive Disequilibrium*, *Origination of Social Interaction*, *Knowledge Evolving*, and *Cognitive Equilibrium*. A list is filled to ensure the fitness of the collaborative e-learning model tasks as well as the collaborative developed Web collaborative e-learning environment with the collaborative e-learning model as illustrated in Table 6.1.

Table 6.1: ShareSpace Evaluation against the Collaborative e-Learning Model

Collaborative E-Learning Model Level	Collaborative E-Learning Model Task	ShareSpace Features and Services
<i>Networking</i>	<i>Knowledge Shifting</i>	<i>Portal Service</i>
<i>Contribution</i>	<i>Knowledge Feeding</i>	<i>Feeding new knowledge</i>
<i>Cognitive Disequilibrium</i>	<i>Knowledge Self-Reflection</i>	<i>Commenting feature</i>
<i>Origination of Social Interaction</i>	<i>Knowledge Negotiation</i>	<i>Lync Web Conferencing</i>
<i>Knowledge Evolving</i>	<i>Knowledge Elaboration</i>	<i>Lync group Whiteboard</i>

<i>Cognitive Equilibrium</i>	<i>Knowledge Accommodation</i>	<i>Office documents library</i>
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6.2 ShareSpace Evaluation Based on Framework for Evaluating Computer Supported Collaborative Learning

ShareSpace is evaluated based on a framework for evaluating computer supported collaborative learning [6] which is presented in section 2.9. This framework is used to examine the presence or the absence of the key five features of collaborative learning which are:

1. **Learners have individual responsibility and accountability:** this feature measures the degree of control learners have in their decisions regarding involvement in the collaborative e-learning sessions. In ShareSpace the learners can join the collaborative group workspace on their pace at the time they prefer. They can make decisions about how and when they completed collaborative e-learning tasks and posted responses.
2. **Learning interaction takes place in small groups:** the basic requirement of conducting a collaborative e-learning session in ShareSpace is the existence of a joined group of learners. Joined learners can form small groups or dyads for each category (course) or all categories (courses).
3. **Communication during learning is interactive and dynamic:** ShareSpace is powered with online Lync service which raises the interactivity and the sociability of the collaborative e-learning sessions. Joined learner can use MS Lync various channels of communication such as : text chatting (IM), video chatting , audio chatting, as well as email which is provided by the Integrated Outlook Email service.
4. **Learners can identify their role in the learning task:** Since ShareSpace is not a group or task-based collaborative e-learning tool. In addition, it is developed independent of any LMS and with no consideration for the instructor involvement. Learner's roles are not defined clearly or predetermined and the learners have the same level of authority. The absence of this feature doesn't represent a shortcoming since ShareSpace is developed to serve informal general learning.

5. **Participants have a shared understanding within the learning environment:** the learners in ShareSpace are motivated to join the group workspace and engaged in a social learning experience based upon their need to gain a shared understanding about a certain category (course). They proof this by their knowledge contribution which are shared and transmitted among their colleagues. Office Web Apps as well as online file sharing provide effective knowledge sharing, also the social dialogue using online Lync Web conferencing assist in knowledge sharing and collaborative construction of this knowledge.

6.3 ShareSpace Evaluation Based on an Adaptable Usability Heuristic Checklist for Online Courses

Online usability is defined as "*The extent to which a Web site can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.*" [27]. In online courses good usability translates to 1 key requirements which are:

- Good usability facilitates learning by having the mechanics of the learning environment transparent to the user.
- Good usability involves easy engagement of the user in the instructional and communication process.
- Good usability involves supporting flexibility for creative endeavors as part of the learning process.
- Good usability involves promoting interactivity

The usability of ShareSpace is examined based on the adaptable usability heuristic checklist for online courses [27] which is reviewed in section 2.10. Interactivity and flexibility are the two most important and critical categories that are related strongly to collaborative e-learning environments. Table 6.2 presents a checklist for interactivity and the flexibility and shows whether they are present or absent in ShareSpace. According to the adaptable usability heuristic checklist ShareSpace enjoys high degree of interactivity and flexibility which raise its realization of a social and interactive collaborative e-learning environment.

Table 6.2: Interactivity and Flexibility Checklist for ShareSpace

Category	Usability Heuristic	Yes	No	N/A
Interactivity	Does the arrangement of topics promote class discussion?	√		
	Can the user follow the progression or flow of discussion of one single topic or across multiple topics?	√		
	Are messages arranged in numerical fashion? Is this effective?	√		
	Are messages arranged in an effective threaded fashion?	√		
	Can selected messages be effectively compiled to read in one sequence?	√		
	Can subject lines be modified?			√
	Can text be edited or modified once posted?	√		
	Can messages be moved to specific locations to another topic area?			
	Can users delete their own messages or text?	√		
	Can users obtain “side-by-side” (multiple) views of contributions to follow the flow of discussion?	√		
	Can users establish a “sense of community” through the arrangement of messages and responses?	√		
	Can messages and responses in one class be shared for another class with appropriate acknowledgement and citation of origin?	√		
	Can designers/instructors extrapolate specific postings from individual students from the discussion board transcript?			√
	Can the designer/instructor extract statistics from the discussion board transcript to show the patterns of interaction produced from the class?			√
	Can users share timely information that can be easily located later for further use?	√		
	Can users communicate with others outside the course?	√		
	Are various interaction patterns (one-to-one, one-to-many, many-to-many) supported in the communication tools?	√		
	Can a “history” of discussion and sharing of resources be captured at any time in the course?	√		
	Can temporal aspects such timing, pace, and sequencing be used effectively in online discussion tools to promote quality interaction?	√		
	Can various activity structures be used in online discussion tools? (For example, activities involving individual students, groups, teams, pairs, rotating groups, other compositions.)	√		
Is it easy to compose a message?	√			

	Does the user have to do excessive scrolling to follow message flow?		√	
	Can messages be easily expanded and collapsed?	√		
	Is there visual feedback in terms of new messages/old messages/other?	√		
	Can the designer/instructor establish and maintain a tone or flavor of his/her own in the course?			√
	Is communication centralized and convenient?	√		
	Can activities be easily monitored by the designer/instructor?			√
Flexibility	Are templates available for the designer to simply “plug in” course content without time consuming and repetitive action sequences?			√
	Are users able to edit messages in email, chat, discussion boards, etc.?	√		
	Does modifying an action or activity require excessive “redoing” to make a single change?		√	
	Can designers/instructors modify settings for individual learners that would not affect the settings for the group as a whole? (For example, extending the due date for an assignment in the drop box for an individual student.)			√
	Can designers/instructors select information for individual students or group students into distinct groups for various purposes?			√
	Is reuse possible without extensive revision or modification to previously used learning objects or course content?	√		
	Can users establish their own defaults for email, discussion groups, icon arrangement, other?	√		
	Can users personalize their online learning environment by adding resources, content, learning objects to their own course page? To what extent can users customize their “view”?	√		
	Are standard templates provided with easy access to personalize or modify things?	√		
	Can learning objects be created and reused?	√		
	Can the user modify the defaults and create his/her own style sheets?	√		
	Does the course support various learning styles?	√		
	Does the course support various modes of learning – asynchronous, synchronous, hybrid?	√		

Chapter 7

Conclusion and Future Work

In this research, four social cognitive development theories namely: Connectivism, Social Cognitive Development, Social Interdependence and Cognitive Elaboration Perspectives were utilized to build a collaborative e-learning model with six levels which explained in chapter 4. The six levels are: *Networking, Contribution, Cognitive Disequilibrium, Origination of Social Interaction, Knowledge Evolving, and Cognitive Equilibrium*. This collaborative e-learning model has six tasks namely: *Knowledge Feeding, Knowledge Self-Reflection, Knowledge Negotiation, Knowledge Elaboration, Knowledge Accommodation and Knowledge Shifting*. The requirements of each task were specified, analyzed and designed to achieve the three core concepts of effective collaborative e-learning which are: interactivity, social context and technology.

The proposed collaborative e-learning model was realized and implemented through developing a Web based collaborative e-learning environment called ShareSpace. ShareSpace was developed using Cloud Computing and Web 2.0 techniques which provided by SharePoint platform. ShareSpace is a learner-centered e-learning environment that supports conducting of informal e-learning without the reliance on a teacher presence. ShareSpace enable the learners to join an online shared space which is empowered with many features that realized the collaborative e-learning model tasks.

In ShareSpace the learners can feed any kind of knowledge. The knowledge feeds are accessible by all the joined learners. They can express their self-reflection on the fed knowledge by multi- type written comments. Various group communication tools are available such as: Email, Text Chat, Audio Chat and Video Chat to promote the social context of *knowledge negotiation*. In addition, ShareSpace support group activities such as: sharing screens, documents coauthoring, programs sharing and whiteboard to ensure the knowledge elaboration. *Knowledge accommodation* can be achieved by the availability of personal and shared documents library as well as a recording utility for the overall online

learning session. *Knowledge shifting* is the essential task which specifies the flow of knowledge transitions in the online shared space.

ShareSpace evaluated based on the collaborative e-learning model, on a framework for evaluating computer supported collaborative learning and on an adaptable usability heuristic checklist for online courses.

The contribution of this research stems from its integrated and coherent proposed collaborative e-learning model which is based on cognitive development theories and its realization and implementation as a rich and powerful Web based learner centered collaborative-learning environment.

The collaborative e-learning model which was proposed in this research can still be enhanced since its design was introduced in a simple and basic manner and it concerned only with how the joined learners can learn collaboratively not what they learn through their collaboration. The learners learn freely and in informal way such that no assessment or evaluation for their interaction through their collaboration. In addition, its implementation and its realization which introduced in ShareSpace were applied independently of any Learning Management System (LMS). The future direction of this research could be summarized in the following enhancements and utilizations:

- Providing the ability to assist and evaluate the collaborative interaction of the learners.
- Enhancing and empowering ShareSpace with social profiling feature for the joined learners.
- Extending ShareSpace to be an integrated LMS which support the learner-centered model as well as the instructor-centered learning model.

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