DEVELOPING A MOBILE LEARNING MANAGEMENT SYSTEM FOR OUTDOORS NATURE SCIENCE ACTIVITIES BASED ON 5E LEARNING CYCLE

Ah-Fur Lai*, Horng-Yih Lai**, Wei-Hsiang Chuang* and Zih-Heng Wu**
*Department of Computer Science, University of Taipei
**National Taiwan University
*No.1, Ai-Guo West Road, Taipei, 10048 Taiwan

ABSTRACT

Traditional outdoor learning activities such as inquiry-based learning in nature science encounter many dilemmas. Due to prompt development of mobile computing and widespread of mobile devices, mobile learning becomes a big trend on education. The main purpose of this study is to develop a mobile-learning management system for overcoming the difficulties of outdoor learning activities. In addition, this study conducted a learning experiment on marine education in an elementary school for investigating its impact on the learners' learning achievement and attitudes, and evaluating the suitability of this system. The results show that the mobile learning model with the system developed by this study has positive and significant effect on learners' cognitive achievement. Nevertheless, the learners' attitudes toward marine education is not enhanced after experiment. In addition, the result of system evaluation reveals that the experts show high appraisal toward this system including system usefulness, suitability and operational easiness.

KEYWORDS

Mobile Learning, 5E learning cycle, outdoor learning activity, nature science

1. INTRODUCTION

Inquiry is the process of humankind for seeking information and understanding, and it is a thinking approach as well (welsh Klopfer & Aikenhead, 1981). Inquiry-based learning is an open ended, student-center teaching strategy, emphasizing hands-on instructional context. In order to construct this kind of learning environment, there are many theoretical approaches proposed, including structured inquiry, guided inquiry, open inquiry, and learning cycle (Colburn, 2000).

In inquiry-based learning (IBL for abbrev.), the students have to represent their problems, develop hypothesis, design experiment, collect and analyze data, propose evidence, and reflect their process. As a result, IBL can make learning more meaningful and enhance the effect of learning transfer (Brown & Campione, 1994; Collins, Brown & Holum, 1991; Linn & His, 2000; Slotta, 2002; White & Frederickson, 1998; Lin, 2004). Nevertheless, IBL has not been widespread applied on educational practicum. Some literature revealed the possible reason of aforementioned phenomena including misunderstanding the meaning of inquiry, IBL regarded as suitable for high ability students merely, uneasy to manage learning activities, inappropriate teaching preparation (Colburn, 2000). In addition, Lai (2014) proposed some factors affecting the teachers' rejecting the IBL, including delay the teaching schedule, bringing too much workload on teachers, the students' time management problem, the teachers unfamiliar with IBL practical models, and lack of suitable digital management system. To reduce the aforementioned dilemma, some suitable learning models are required for practicum, and ICT-based learning management system is also necessary for delineating the teachers' work load and providing real time supports for the students.

Many IBL models offering concrete guidance can be suitably used for practical teaching and learning, such as Bishop and Bruce model (2002), Learning-for-use model (Edelson, 2001), and 5E learning cycle. The stages of Bishop and Bruce model consist of Ask, Investigate, Create, Discuss and Reflect. According to perspectives of constructivist, 5E learning cycle proposed by Biological Science Curriculum Improvement Study (BSCS) is regarded as an effective science pedagogy (Bybee & Landes, 1998; Bybee et al., 2006; Liu, Peng, Wu & Lin, 2009). 5E learning cycle is comprised of five stages including Engage, Explore, Explain, Elaborate and Evaluate.

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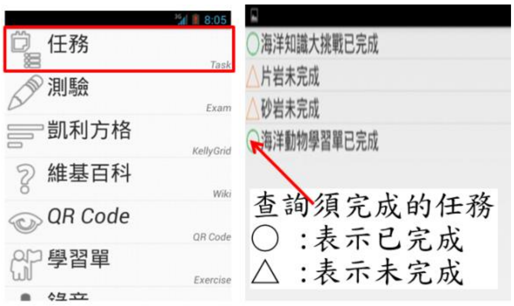
2. SYSTEM FRAMEWORK AND FUNCTIONS

In order to support outdoor science activities, this study developed a mobile learning management system (MLMS for abbrev.), and its framework is shown as Figure 1. MLMS consists of teacher-side learning management subsystem and learner-side learning support subsystem.

Based on the theory of 5e learning cycle, the functions of learning support subsystem (Android-based APPs) for the students designed by Android java are depicted as follows: (1) Engage: To invoke the learners engage in the outdoor activities, the task-notify APP is designed, shown as Figure 1. (2)Explore: In this stage, the Kelly-grid APP can help the learners to observe the object specified by the teacher. Figure 2 presents a learning task of observing the crab of seashore specified in Kelly grid by the teacher. When the learners finish their task, the corresponding diagnostic message will be sent in mobile device for feedback or suggesting one furthermore observation if the student's answer is incorrect. (3)Explain: In this stage, the teachers will provide the opportunities for explaining their learning, so the mobile-based worksheet App can facilitate the learner to collect and depict their findings by capturing image, annotating and writing text in their mobile devices, shown as Figure 3. When they encounter some problems, they can use QRCode for acquiring correct concepts or seeking solutions through Wikipedia and other search engines. (4)Elaborate: According to the cognitive elaboration theorem, the teachers can propose challenging and minds-on problems, and the learners are asked to solve it using elaborating concepts. In this study, the location-based knowledge construction App is offered when the learners are asked to finish a task, such as introducing the seashore spot of Taiwan, shown as Figure 3. (5)Evaluate: How to assess the learners' performance is an important duty. In this study, the teachers can conduct peer assessment activities for evaluating the students' works or ask the students to take a mobile-based test at the end of an outdoors activity. Figure 4 shows the peer assessment frame of mobile device and presents a mobile-bases test. Moreover, the profile of the learners will be recorded and upload into web server for further analysis.

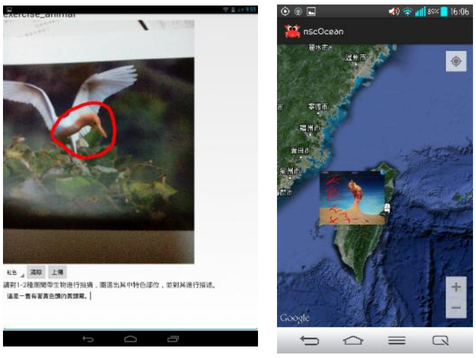
As for the teacher-side functions, the web-based learning management subsystem can be divided into the following modules: (1)Kelly grid authoring: The teachers can edit Kelly grid for providing a series of observation task; (2) mobile test editing: The teachers can manage the test item bank and schedule a task of mobile test, as shown as Figure 5; (3) peer assessment management: The teachers can schedule a peer assessment task for some mobile worksheets; (4)task scheduling: All of task can be assigned and tuned by teachers. (5) viewing the learning status and outcomes: the teachers can monitor the learner's task status, observation result in Kelly-grid, and score of test or peer assessment, as shown as Figure 6.



(A) (B)

Figure 1. (A)partial system menu (B)Task-notify APP

Figure 2. Kelly-grid and its feedback



(A) (B)

Figure 3. (A) mobile worksheet (B) An example of location-based knowledge construction

After finishing the development of this system and APP, this study employed 17 experts for evaluating the aforementioned system and APP, including 14 experienced teachers of elementary schools, 3 project managers, and 2 experienced programmers. The evaluation questionnaire adopted 5-point Likert scale, ranking from strongly agree to strongly disagree. The facets of this instrument consist of system helpfulness, suitability and operational easiness. After analyzing the data collected from pilot study, the Cronbach's alpha of each facet is over 0.7, revealing that this instrument is reliable.

(A) (B)

Figure 4. (A) mobile-based test (B) peer assessment

Figure 5. Mobile test editing

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Figure 6. Viewing the learners' mobile worksheets

3. OUTDOOR MOBILE LEARNING EXPERIMENT

In order to investigate the learning effect of outdoor mobile learning, this study conducted a learning experiment by employing quasi experimental design. The subjects are 160 fifth graders from six classes in Taipei city, divided into experiment group (n=80) and control group (n=80). The experiment group accepted mobile learning approach, while the control group accepted traditional learning pedagogy. All of the subjects were asked to explore the plants and animals of specified seashore spot at northern Taiwan. The experiment group used Android Pads with aforementioned system and APPs for outdoor learning activities, on the contrary, the control group used traditional devices for recording their observation under directions of paper-based worksheets and learning materials. The educational target of outdoor learning of this activity is one of the elementary marine education. The subjects were asked to take cognitive tests of marine achievement and to fill out the self-reported inventory of learning attitudes toward marine education. The experimental design for outdoor activity in this learning experiment is shown as Table 1.

Table 1. Experimental design for outdoor activity

Pretest	Treatment	Posttest
O_1O_2	X	O_3O_4
O_1O_2		O_3O_4

O_1 : pretest of achievement test on marine education
O_2 : pretest of learning attitudes towards marine education
X: experiment group accepts mobile learning model, and control group accepts traditional learning pedagogy
O_3 : posttest of achievement test on marine education
O_4 : posttest of learning attitudes towards marine education

The inventory of learning attitudes consists of interest, usefulness, importance, and awareness toward marine education, adopting 5-point Likert scale. This instrument is validated by experts of marine educations. Its Cronbach's alpha is .806 by analyzing the data collected from pilot test, indicating that it is highly reliable. The achievement test of marine education contains the concepts of plants and animals of seashores. After item analysis from pilot test, its difficulty index range from 0.4 to 0.7, and its discrimination index range from 0.4 to 0.8, depicting that they are all suitable for assessing the learners' achievement based on viewpoint of Ebel and Frisbie (1991).

4. RESEARCH RESULTS

4.1 Results of Achievement test for Marine Education

The descriptive statistical results of achievement test for marine education are shown as Table 2, and its results of independent t test are depicted as Table 3. As for pretest of achievement test, there is no significant difference between experiment group (M=4.90, SD=2.949) and control group (M=4.31, SD=2.917), t=1.237, p>.05, indicating that those two groups possess the same prior knowledge on marine education before learning experiment. As for posttest of achievement test, there is significant difference between experiment group (M=9.61, SD=3.438) and control group (M=7.94, SD=4.018), t=2.727, p<.01, indicating that the experiment group divergently outperform on achievement test of marine education than the control group after learning experiment. In other words, the outdoor learning model with the aforementioned system and mobile devices can enhance the learning effect on marine education. The research results are same as those of Lai, Chou, Wu and Lai (2010) which employed RFID and PDA for conducting an experiment of learning aquatic plants in an elementary school.

Table 2. Pretest and posttest scores of achievement test for marine education

Test	Group	n	Mean	SD
Pretest	Experiment group	73	4.90	2.949
	Control group	77	4.31	2.917
posttest	Experiment group	72	9.61	3.438
	Control group	77	7.94	4.018

Table 3. Results of independent t test on achievement test for marine education

Achievement Test	Levene's Homogeneity test		*t*	df	Sig.
	F	Sig.			
pretest	.046	.831	1.237	148	.218
posttest	2.877	.092	2.727**	147	.007

***p<.01*

4.2 Results of Learning Attitudes towards Marine Education

The inventory of learning attitudes towards marine education is a kind of self-reported instrument, and it consists of four facets including interest, usefulness, importance, and awareness towards marine education. Its results of independent t test are depicted as Table 4. As for pretest of learning attitudes, there is no significant difference between experiment group (M=89.54, SD=13.311) and control group (M=91.1, SD=15.656), *t=-.589, p>.05,* indicating that those attitudes of two groups are the same before learning experiment. As for posttest of learning attitudes, there is no significant difference between experiment group (M=89.95, SD=12.975) and control group (M=91.65, SD=14.436), *t=-.706, p>.05.* In other words, mobile learning model cannot promote the learners' learning attitudes in a short-term leaning time.

Table 4. Results of independent t test on learning attitudes towards marine education

Learning attitudes	Levene's Homogeneity test		t	df	Sig.
	F	Sig.			
pretest	.333	.565	-.589	122	.557
posttest	1.191	.277	-.706	129	.481

4.3 The Results of System Evaluation

The results of system evaluation are shown as Table 6, and average of each item range from 3.41 to 4.35. The average of this system evaluation is 4.016, revealing that the experts show high appraisal toward this system. Nevertheless, the system flow is required to revise in the future.

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Table 5. The results of system evaluation

Items	A(%)	B(%)	C(%)	D(%)	E(%)	M	SD
This APP on mobile inquiry learning is helpful.	23.5	76.5	0	0	0	4.24	.437
This APP is useful for mobile inquiry learning in elementary school.	35.3	64.7	0	0	0	4.35	.493
This system recording the learners' behaviors is helpful to capture learners' status for the teachers	11.8	76.5	11.8	0	0	4.00	.500
The testing function of this APP is help for outdoor learning activities.	5.9	94.1	0	0	0	4.06	.243
The operational flow of this APP is smooth.	11.8	35.3	41.2	5.9	5.9	3.41	1.00
This APP make outdoor learning more fun.	5.9	88.2	5.9	0	0	4.00	.354
This APP can attract the learners engage in learning.	23.5	70.6	5.9	0	0	4.18	.529
This mobile outdoor learning mobile is suitable.	5.9	76.5	17.6	0	0	3.88	.485
The multimedia materials through QRcode is helpful.	41.2	41.2	17.6	0	0	4.24	.752
Operating this system is easy.	5.9	58.8	35.3	0	0	3.71	.588
The web-based management of this system is easy to use.	5.9	58.8	29.4	5.9	0	3.65	.702
This system and APP can be used for different outdoor activities.	23.5	76.5	0	0	0	4.24	.437
This APP is suitable for indoor, campus-wide and outdoor learning activities.	23.5	58.8	17.6	0	0	4.06	.659
The functions of task-hinting is useful.	11.8	82.4	5.9	0	0	4.06	.429
The Kelly-grid and its real-time feedback is helpful for understanding their learning drawbacks.	11.8	52.9	29.4	5.9	0	3.71	.772
The mobile worksheet is suitable.	23.5	76.5	0	0	0	4.24	.437
The peer assessment of this system is helpful.	17.6	76.5	5.9	0	0	4.12	.485
The mobile worksheet integrating image and voice recording is interesting.	29.4	70.6	0	0	0	4.29	.470
If I am a teacher of nature science, I am willing to apply it in my teaching practicum.	23.5	64.7	11.8	0	0	4.12	.600
I am willing to recommend this system to other teachers.	35.3	47.1	17.6	0	0	4.18	.728

A: strongly agree, B: agree, C: medium, D: disagree, E: strongly disagree

5. CONCLUSIONS AND FUTURE WORKS

In order to offer real time support for outdoor learning activities, this study adopted mobile computing technology to develop a mobile learning management system and APP. Based on the theory of 5e learning cycle, this system provides different functions for each inquiry learning stage including Engage, Explore, Explain, Elaborate, and Evaluate stage, in outdoor inquiry-based learning. After system evaluation, the experts show high appraisal toward this system including system usefulness, suitability and operational easiness. Through short-term learning experiment on marine education, the outdoor mobile learning model can significantly improve the achievement of experiment group as compared to those of control group under traditional teaching pedagogy. Nevertheless, the learning attitude towards marine education is not promoted divergently after learning experiment.

In the future, this study will launch a long term learning experiment for nature science, and apply it on different learning domain for investigating its effect on learners' high order thinking skills including metacognition, communication skills and science process skills by using mobile learning model.

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