Development of a Mobile Learning System for Local Culture Courses based on a Collaborative Problem-Posing Strategy

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Abstract: With the help of mobile and wireless communication technologies, students can be situated in a real-world scenario associated with the learning content. Such an approach has been recognized by researchers as being a promising way of assisting students in linking their prior knowledge learned from the textbooks to their real-world experiences. On the other hand, researchers have also indicated that the effectiveness of such a learning approach might not be as good as expected if no proper learning strategy or tool is provided to guide or support the students during the learning process. In this study, a problem-posing strategy is proposed for supporting collaborative mobile learning activities. Accordingly, a mobile learning environment has been developed, and an experiment on a local culture course has been conducted in southern Taiwan to evaluate the effectiveness of the proposed approach. The experimental results show that the new approach is able to improve the students' learning achievement.

Keywords: Mobile learning, Problem-posing strategy, Local culture course, Collaborative learning

1. Introduction

The rapid advancement and popularity of mobile and wireless communication technologies have provided good opportunities for developing learning environments to accomplish such technology-enhanced real-world learning [6] [12]; that is, students are situated in the real-world scenarios with access to digital resources via mobile devices and wireless communication networks, which has been called mobile or ubiquitous learning by researchers [11] [17] [18].

While many studies have reported the helpfulness of mobile learning in terms of improving learners' motivation and interest, the effeteness of such a learning approach in improving students' learning achievement has become a concern. Several researchers have indicated that, without proper learning supports, students' learning achievements could be disappointing [5] [10]. Hwang, Wu, Tseng and Huang (2011) further indicated that most students might fail to organize what they observed or learned in the fields without learning guidance or support in facing such an information-rich environment that combines real-world and digital-world learning materials [13]. Thereofre, reseachers have suggested the importance and necessity of developing effective learning strategies or tools to assist students in organizing what they have learned from fields as well as the textbooks [15] [16].

To cope with this problem, in this study proposes, a three-stage problem-posing approach is proposed for in-field collaborative learning. Moreover, a mobile learning system has been developed based on the proposed approach. The experimental results on an elementary school local culture course show that the proposed approach not only promotes the students' local culture identity, but also improves their learning achievement and group efficacy.

2. Literature Review

Problem posing has been recognized as being a significant component of various curriculums. It involves the generation of new problems related to an issue or situation, including identifying the key elements of a problem and how they relate to the learning objective [7]. In the past decades, problem-solving strategies have been applied to the learning activities of various courses. For example, Casagrande et al. (1998) employed the problem-posing strategy in the practice of the health professional and found it adequate to be applied in several modalities of health care settings, in particular, in nursing training [2]. Several previous studies also suggested that engaging in the question-posing process could benefit students in terms of cognitive growth [1].

Recent advancement of computer and network technologies has encouraged researchers to develop computer-based or web-based learning systems to facilitate students to learn and practice. However, most technology-enhanced learning activities or learning environments for enhancing students' learning performance were designed and developed mainly by providing students with drill-and-practice activities related to the learning objectives [21]. Yu, Liu and Chan (2004) indicated that, in such drill-and-practice systems, students can only respond to questions proposed by teachers [20]. They further indicated that, it would benefit students more if the learning systems enabled and encouraged students to pose questions based on the knowledge or concepts that they learned and perceived as being important and worth discussing.

In recent years, some researchers have attempted to develop problem-posing systems to help learners organize and make reflections during the learning process [8]. For example, Chang (2007) and Chang, Wu, Weng and Sung (2012) developed problem-posing systems for mathematics courses [4] [3]. Both the studies reported that such an approach could help the students more concentrate on what they were learning and gain better problem-posing abilities.

3. Mobile Learning System with a Collaborative Problem-Posing Strategy

In this study, a collaborative mobile learning system based on a problem-posing strategy is developed, which consists of a "key element identification" phase and a "problem posing-guiding" phase. After the logging in the learning system, the students are guided to find a set of learning targets in small groups. When a group of students arrive at the location a learning target, the students asks the students to confirm their location by using the smart phones to scan the QR code on the target. After confirming the location of the group, the learning system presents the learning tasks and supplementary materials to the students. Following that, a series of questions are presented to the students to guide them to observe and identify the key elements of the learning target. If the students correctly answer the questions, an assistance procedure is invoked to guide the students to pose questions.
In the "key element identification" phase, the mobile learning system guides the students to individual learning targets in fields, and presents a series of questions and the

corresponding supplementary materials to guide the students to identify key elements related to the learning targets, as shown in Figure 1. If the students fail to correctly answer the questions for the first time, the learning system will give some hints to guide them to make further observations and read the supplementary materials. If the students fail to give correct answers again, the learning system will then present the correct answers to them.

Figure 1. Illustrative example of guiding the students to observe the learning targets in fields

The problem posing-guiding strategy proposed in this study refers to the "pose", "plan", "carry out" and "reflect" features presented in the work of Leung (1993) [14]. It consists of three stages. In the first stage, some clues, related to the learning targets, such as the characteristics, background history and ancient customs of the local culture artworks, are given to the students to help them raise questions, as shown in the left part of Figure 2. Following that, in the second stage, some question templates, which are generated based on the questions proposed by domain experts (or teachers), are presented to the students. A question template can be viewed as a fill-in-the-blank question in which the key elements are removed from the experts' questions, as shown in the right part of Figure 2. Those templates are used to guide the students to re-consider and modify the problems they have raised. In the third stage, the experts' questions are presented to the students to help them make reflections on what they have posed.

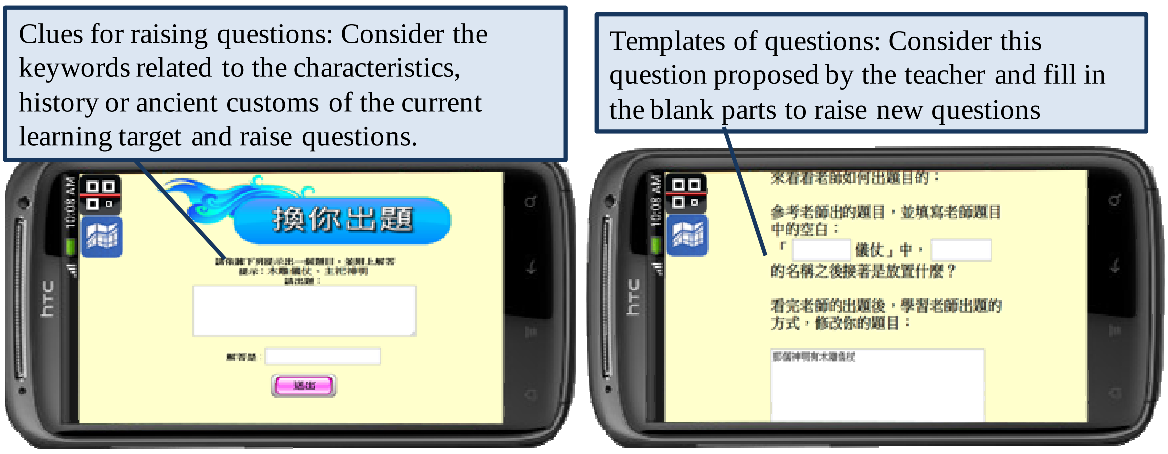

Figure 2. Illustrative example of the problem posing-guiding mechanism

4. Experiment design

To evaluate the effectiveness of the innovative approach, a mobile learning activity was designed for an elementary school local culture course. The learning environment was Chao-Xing temple in southern Taiwan. An experiment was conducted to compare the learning achievements, self-efficiency and the local culture identity of the students who participated in the problem-posing based mobile learning system with different learning strategies.

4.1 Learning environment

In this mobile learning environment, a local wireless communication network was installed, such that the students were able to interact with the mobile learning system during the in-field learning process. The learning content consisted of five main parts, that is, the ancient customs, history, carving art, murals painted and the gods in the temple. Each part contains two to five main learning targets, such as the stone-carved lions at the main hall and the long-pan pillars at the front hall, each of which has its own historical story and is related to particular ancient customs.

4.2 Experimental procedure

The experiment was conducted for an elementary school local culture course, which aimed to guide the students to understand the local cultural history, the transit of local culture and the ancient customs via observing the artworks and the cultural relics in the temple. It was expected that the students would be able to blend harmoniously and grasp thoroughly the history or ancient customs of and the relationships between those learning targets through the learning activity.

Figure 3 shows the procedure of the learning activity, which consists of two learning phases conducted in two weeks. In the first week, in-class learning for the local cultural course was conducted. In this phase, the three groups of students were instructed by the same teacher about the basic knowledge of the local culture. Following the instruction, the students took the pre-test. The pre-test aimed to evaluate their basic knowledge about the local culture.

In the second week, the in-field learning activity was conducted. At the beginning of this phase, the teacher introduced the Chao-Xing temple and the learning targets in the temple; moreover, a demonstration was given to show them how to use the smartphones and interact with the learning system via scanning the QR-codes. During the in-field learning activity, the students learned in small groups. Each learning group consisted of a high-achieving, a middle-achieving and a low-achieving student, that is, a heterogeneous grouping approach was adopted.

The learning activities lasted one hundred and twenty minutes. Each student in the two experimental groups was equipped with a smart phone to interact with the mobile learning system and access supplemental materials. The students in Experimental Group A learned with the collaborative problem posing-based mobile learning approach, while those in Experimental Group B learned with collaborative mobile learning approach. On the other hand, the students in the control group learned with the traditional collaborative learning approach, that is, they were guided and instructed by the teacher to observe each learning target and complete the learning sheet.

After the learning activity, the students were asked to fill out the post-test. In addition, they were asked to fill out the questionnaire of cognitive load. Finally, the researchers interviewed the teachers and students to collect their opinions and learning perceptions about the learning approaches.

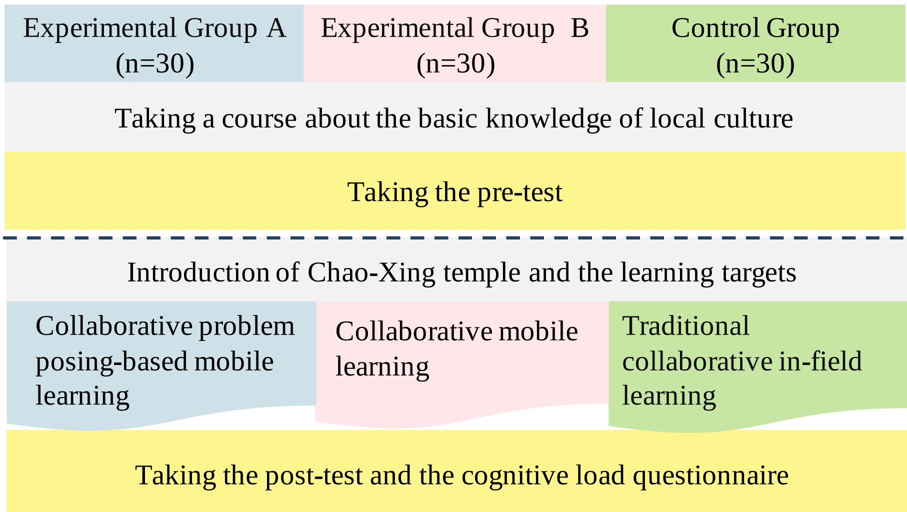

Figure 3. Experimental design for the learning activities

4.3 Participants

The participants of the experiment were three classes of fifth graders in an elementary school in southern Taiwan. A total of ninety students participated in this study. One class with was assigned to be Experimental Group A, one class was Experimental Group B, and the other class was the control group. Each of the three groups included thirty students. The three classes were taught by the same instructor. In addition, to avoid the Hawthorne effect, the three groups were arranged to visit the temple in different time periods.

4.4 Measuring tools

The measuring tools of this study include the pre-test, the post-test, and the questionnaires for measuring the cognitive load of students. The pre-test aimed to evaluate whether the three groups of students had an equivalent prior knowledge before participating in the learning activity. It consisted of fifteen fill-in-the-blank questions (60%) and eight short answer questions (40%) about the basic knowledge of local culture. The post-test consisted of twenty multiple-choice items (40%), eight short answer questions (48%) and two open-ended questions (12%) for assessing the students' knowledge of the differentiating cultural relics and ancient customs. Both the pre-test and post-test were designed by two experts who had more than 10 years experience in teaching local culture courses.

The cognitive load questionnaire was modified from the cognitive load measure developed by Sweller, Van Merriënboer and Paas (1998) [19]. It consisted of four items, including two items for the "mental load" dimension and two items for the "mental effort" dimension with a seven-point Likert scale. The Cronbach's α values of the two dimensions were 0.85 and 0.86, respectively.

5. Experiment design

In the present study, the collected data were first examined by descriptive statistics to explore the group means, standard deviations and numbers. Then, one-directional analysis of variance (ANOVA) was performed on the pre-test grades. Analysis of covariance (ANCOVA) was also conducted to examine the effects of using the proposed approach on students' social science learning achievements and on their perceptions of the learning activity. In addition, the local culture identity, self-efficacy of group learning and cognitive load of the students were analyzed.

5.1 Learning achievement

Before participating in the learning activity, the students took a pre-test to evaluate their basic knowledge of the science course content. A one-way ANOVA was performed on the pre-test results, the mean values and standard deviations of the pre-test scores were 84.96 and 14.08 for the experimental group A, and 85.92 and 14.53 for the experimental group B, and 82.46 and 10.81 for the control group. Which showed non-significant difference of the independent variable and the covariate of the learning achievement test ($F(2, 76) = 0.47$, $p>.05$) among the pre-test results of the students in the three groups. Consequently, it is concluded that the three groups had equivalent prior knowledge before the learning activity.

After conducting the learning activity, ANCOVA was performed on the post-test results, in which the pre-test was the covariant, the post-test results were the dependent variable and the "different collaborative learning strategies (three groups)" were the control variable, to compare the post-test results of the three groups. As shown in Table 1, the ANCOVA result shows that the difference between the three groups was significant ($F(2, 76) = 5.54$, $p<.01$) after the impact of the pre-test scores on the post-test was excluded, implying that the post-test scores of the three groups were significantly different due to the different experimental learning processes. Furthermore, post hoc analysis was performed to examine specific differences in achievement between the experimental groups. An LSD test revealed that the experimental group A scores were significantly higher than those of experimental group B, comparing the adjusted mean of 74.51 for the experimental group A with the experimental group B score of 60.90 ($p<.01$). Additionally, the experimental group scores were also significantly higher than those of control group which scored 65.72 ($p< .01$).

Accordingly, it was concluded that the collaborative problem posing-based mobile learning system was helpful to the students in improving their learning achievements in comparison with the collaborative mobile learning and the traditional collaborative in-field learning approaches.

Table 1. ANCOVA result of the learning achievement post-test for the three groups

Variable	Group	N	Mean	S.D.	Adjusted Mean	*F* (2,76)	Post Hoc (LSD)
Post-test	(1) Experimental group A	27	74.89	17.50	74.51	5. 54**	(1) > (2)
	(2) Experimental group B	26	62.00	19.75	60.90		(1) > (3)
	(3) Control group	26	64.23	16.56	65.72		

$^{**}p <.01$

5.2 Cognitive load

In addition to learning achievement, it is worth investigating whether the innovative approach increased the learning pressure of the students. Consequently, the cognitive load measure was used to compare the pressure of the students from two aspects; that is, mental load and mental effort. The former is concerned with pressure caused by the amount of information presented to the learners and whether the difficulty of learning content meets their knowledge levels, while the latter is related to the pressure caused by the way of structuring the information or the adopted learning strategy [19] [9].

Table 2 illustrates the ANOVA results on the mental load and mental efforts scores of the three groups. No significant differences were found between the two cognitive load dimensions of the three groups with F (2, 76) = 1.51 and p>.05 for mental effort and F (2, 76) = 0.02 and p>.05 for mental load. It can be inferred that the collaborative mobile learning system with problem-posing approach did not increase the cognitive load of the students although its learning procedure seems to be more complex than the other two approaches.

Table 2. The ANOVA result of the cognitive load test for the three groups

Variable and source	Experimental Group A		Experimental Group B		Control Group		
	Mean	SD	Mean	SD	Mean	SD	*F* (2, 76)
Mental Effort	2.48	1.89	3.25	1.58	3.17	1.84	1.51
Mental Load	3.93	2.39	3.83	1.94	3.81	2.12	0.02

6. Discussion and Conclusions

In this study, a two phase problem-posing strategy is proposed for helping students identify key element of real-world learning targets and link what they have learned in fields to their prior knowledge learned from the textbooks. An experiment has been conducted on an elementary school local culture course to evaluate the effectiveness of the proposed approach. The experimental results show that the problem posing-based collaborative mobile learning approach is helpful to the students in improving their learning achievements.

In the meantime, the measuring result also shows that, with proper learning design, the lead-in of learning support tools or strategies does not significantly increase the cognitive load of students although mobile learning scenarios that combined both real-world and digital-world resources are much more complex than those of web-based learning. Consequently, it is worth investigating the effects of other computer-assisted learning strategies or tools on students' learning performance and perceptions in mobile learning settings. For example, it is an interesting issue to use several well-known Mindtools, such as concept maps, expert systems, databases and spreadsheets, in mobile learning environments.

On the other hand, it is also worth investigating the effects of applying the problem-posing strategy proposed in this study to other courses and other graders, such as science courses in elementary schools, mathematics courses in high schools, and engineering courses in universities.

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