Effects of the Mobile Competitive Game Approach on Students' Learning Attitudes and Flow Experience in Field ....

Article · December 2014

DOI: 10.1109/EITT.2014.9

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British Journal of Educational Technology (2015)
doi:10.1111/bjet.12303

Effects of a peer competition-based mobile learning approach on students' affective domain exhibition in social studies courses

Gwo-Jen Hwang and Shao-Chen Chang

Gwo-Jen Hwang is a Chair Professor in the Graduate Institute of Digital Learning and Education at National Taiwan University of Science and Technology, Taipei, Taiwan. Shao-Chen Chang is a PhD student in the Graduate Institute of Applied Science and Technology at National Taiwan University of Science and Technology, Taipei, Taiwan. Address for correspondence: Professor Gwo-Jen Hwang, National Taiwan University of Science and Technology, Graduate Institute of Digital Learning and Education, #43, Section 4, Keelung Road, Taipei, 106, Taiwan. Email: gjhwang.academic@gmail.com/gjhwang@mail.ntust.edu.tw

Abstract

One of the important and challenging objectives of social studies courses is to promote students' affective domain exhibition, including learning interest, positive attitudes and local culture identity. In this paper, a location-aware mobile learning approach was proposed based on a competition strategy for conducting local cultural activities in the field. During the field trip, the learners were asked to learn in the mobile learning environment by throwing a dice to determine their moves using a tablet computer. Each move was related to a problem-based learning task associated with the corresponding real-world target at the specified location. To assess the effects of the peer competition-based mobile learning approach on students' affective domain exhibition, a quasi-experimental design was employed to conduct a learning activity in the social studies course of an elementary school. From the experimental results, it was found that the proposed approach significantly improved the students' local culture identity, learning interest, and learning attitudes; moreover, it also decreased their cognitive load when guiding them to learn in the field trip.

Introduction

Improving students' affective domain exhibition, such as learning attitude and cultural identification, has been recognized as the major objective for social studies courses in elementary schools (Crowe, 2004). In social studies courses, teachers may arrange students to visit ancient assets or temples surrounding their schools to help them realize the value of their local culture. However, it is difficult to have the students pay full attention to those cultural or historical relics during the field trip, not to mention promoting their learning interest, attitude or cultural identity (Chen, Shih & Ma, 2014; Chu, 2014).

The advancement of emerging computing technologies, such as smartphones and tablet computers, has provided an opportunity that enables students to interact with learning systems when observing or acquiring knowledge in the real world (Kearney, Schuck, Burden & Aubusson, 2012). Researchers have called the learning approach that uses mobile devices with wireless network access to provide learning supports in real-world activities "mobile learning (m-learning)" (Hemmi, Narumi-Munro, Alexander, Parker & Yamauchi, 2014; Tan, Ooi, Leong & Lin, 2014) or "ubiquitous learning (u-learning)" (Hwang, Tsai & Yang, 2008; Klopfer, Sheldon, Perry & Chen, 2012). The former emphasizes the adoption of mobile technologies and the

Practitioner Notes

What is already known about this topic

- Situating students in real-world learning contexts is important.
- Promoting students' affective domain exhibition, including learning interest, positive attitudes and local culture identity, is an important educational objective of many courses, such as social studies.
- Competition strategy has great potential for encouraging students to learn and accept challenges during the learning process.

What this paper adds

- A peer competition-based mobile learning approach is proposed for conducting in-field learning activities.
- It is found that students' affective domain exhibition, including learning interest, positive attitudes and local culture identity, can be improved by leading in the peer competition strategy on the field trip.

Implications for practice and/or policy

- In addition to collaboration, peer competition is a good strategy for encouraging students to actively learn and accept challenges.
- It is worth encouraging researchers to develop more peer-competition strategies by taking the knowledge levels or learning styles of students into account when designing mobile learning activities.
- It is also worth encouraging researchers and school teachers to apply peer-competition strategies for mobile learning in different courses.

mobility of learners, while the latter emphasizes that people can acquire knowledge without being constrained by location or time (Franklin, 2011). With the help of mobile and wireless communication technologies, students can learn in the real world with guidance or supplementary materials provided by the learning system. However, most previous studies mainly pay attention to the improvement in students' cognitive domain performance (Martin & Ertzberger, 2013; Sandberg, Maris & Hoogendoorn, 2014; Yang, Chen, Sutinen, Anderson & Wen, 2013), while few of them focus on promoting students' affective domain exhibition (Chen *et al*, 2014; Chu, 2014). In particular, in local cultural courses, field trips are usually conducted in ancient buildings, such as temples in the local areas, which are unfamiliar to young students; therefore, it is difficult to improve students' cultural identity, learning interest, or attitudes on field trips.

On the other hand, competition strategy has been reported as an efficient way of engaging people in exciting and pleasurable activities to achieve challenging tasks (Fu, Wu & Ho, 2009; Lin, Wang, Tsai & Hsu, 2010; Sánchez & Olivares, 2011; Tan *et al*, 2014). To improve students' exhibition in the affective domain via field trips, a peer competition-based m-learning approach is proposed in this study. It is expected that students can fully participate in the learning tasks via the provision of the competitive and exciting scenarios in the real world. To assess the performance of the approach, a research has been carried out in an elementary school local culture course.

Literature review

In-field mobile learning

A frequently adopted definition of mobile learning is the use of mobile technologies in educational settings (Sharples, 2009). Via using mobile devices with wireless communications,

learners are allowed to interact with peers, teachers and the learning system whenever they need (Hwang *et al*, 2008; Ogata *et al*, 2011); that is, learning space is no longer limited to the classroom or even to the school campus. In the past decade, much research has reported the benefits of applying mobile technologies to different courses in school settings, such as science (Looi *et al*, 2014), social science (Hwang, Wu, Zhuang & Huang, 2013), history (Charitonos, Blake, Scanlon & Jones, 2012), biology (Gedik, Hanci-Karademirci, Kursun & Cagiltay, 2012) and language courses (Liu & Chu, 2010; Hwang & Su, 2012). For example, Charitonos *et al* (2012) presented a study which employed mobile devices to enhance peer interactions and knowledge sharing on a field trip. In the meantime, Gedik *et al* (2012) reported the findings of a m-learning activity for 11th graders that the students' perceptions of participation and learning satisfaction were significantly improved. Recently, Chen and Huang (2012) developed a location-aware u-learning system for conducting in-field activities for a natural science course. In the meantime, Hwang *et al* (2013) conducted an in-field activity for a local culture course by situating the fifth grade students in a temple for completing their learning tasks using mobile devices with access to the Internet.

On the other hand, several researchers have reported possible negative impacts of mobile learning because of the improper learning design or the lack of learning supports (Chu, 2014; Hwang, Hung, Chen & Liu, 2014; Sung, Hwang, Liu & Chiu, 2014). For example, Chu (2014) carried out a mobile learning activity based on a formative assessment strategy. The students were situated in problem-based learning contexts, in which they need to answer questions via seeking answers in the real-world environment. The experimental results revealed, however, that the participants' cognitive loads were significantly increased and their learning achievements were disappointing. Therefore, it is necessary to incorporate effective learning methods into mobile learning settings so that students' affective domain exhibition and cognitive load can be improved.

Competition strategy

Competition is the act of attempting or making efforts to gain what another is endeavoring to gain at the same time (Deutsch, 1973). Researchers have pointed out the potential of competition strategies in affecting students' learning motivation (Admiraal, Huizenga, Akkerman & Dam, 2011; Dolgov, Graves, Nearents, Schwark & Brooks Volkman, 2014; Pe-Than, Goh & Lee, 2014). Several earlier studies have reported that competitive situations not only constantly provide external stimulations to students during the learning process, but also positively affect their level and efficiency of acquiring and accumulating knowledge (Nonaka, Umemoto & Sasaki, 1998; Skon, Johnson & Johnson, 1981). Burguillo (2010) further pointed out that competitive situations might stimulate students' will to accept challenges of learning tasks, and hence enhance their learning performance and motivation.

In traditional classroom instruction, competition pedagogies have been widely adopted and have been shown to be effective for various courses (Lin *et al*, 2010; Sánchez & Olivares, 2011), such as language (Hemmi *et al*, 2014; Wong, Hsu, Sun & Boticki, 2013), history (Admiraal *et al*, 2011; Charitonos *et al*, 2012), business (Lin *et al*, 2010), computer programming (Sánchez & Olivares, 2011) and sports (Dolgov *et al*, 2014). The potential of competitive strategies in learning has been identified by several researchers from various aspects, such as motivating students to learn (Admiraal *et al*, 2011; Chen, 2014; Sánchez & Olivares, 2011; Wong *et al*, 2013) and promoting social interactions among peers (Chen, 2014; Hwang, Hong, Cheng, Peng & Wu, 2013; Peng & Hsieh, 2012). Hwang *et al* (2013) further reported the advantages of competitive learning activities in improving learners' attitude; in the meantime, they also indicated the necessity of avoiding high cognitive load when employing competitive strategies in school settings.

In this study, we propose a peer-competition strategy for conducting an in-field mobile learning activity as part of a social studies course. Via applying the approach to local cultural courses, we aim to improve students' local cultural identity, learning interest and attitude, as well as decreasing their cognitive load.

Accordingly, the following research questions are examined:

1 What is the effect of the peer competition-based m-learning approach on the students' learning interest in comparison with conventional m-learning?
2 What is the effect of the peer competition-based m-learning approach on the students' learning attitude in comparison with conventional m-learning?
3 What is the effect of the peer competition-based m-learning approach on the students' local culture identity in comparison with conventional m-learning?
4 What is effect of the peer competition-based m-learning approach on the students' cognitive load in comparison with conventional m-learning?

Development of a peer competition-based mobile learning system

In this study, a mobile learning system was developed for conducting local cultural activities based on a peer-competition strategy. Figure 1 shows the structure of the learning environment, which consists of a learning interface, an information search interface, a learning management mechanism, and a competition mechanism; in addition, there are several databases, including the databases for storing students' profiles, learning portfolios, question items and learning materials.

The learning interface is presented as a map. Each location on the map is associated with a real-world learning target with a set of relevant questions, as depicted in Figure 2. During the

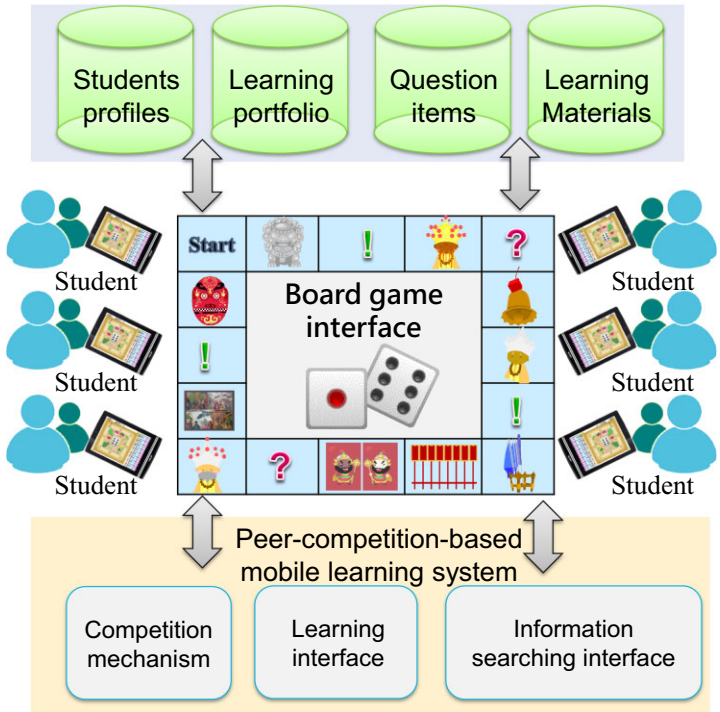

Figure 1: Structure of the peer competition-based mobile learning environment

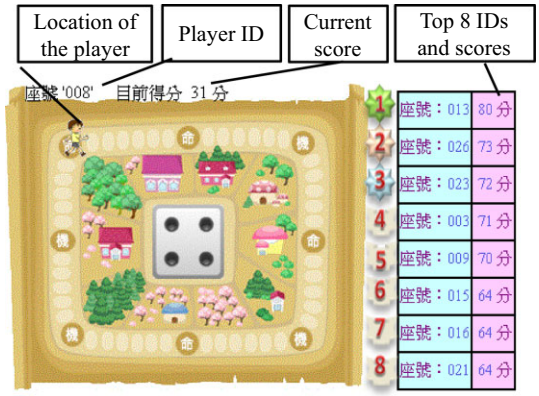

Figure 2: Interface of the peer competition-based m-learning system

learning process, students need to throw a dice to determine their number of steps (ie, 1 to 6). When students arrive at a location, one task is selected from the corresponding set. A learning task could be a multiple-choice question that engages the students in observing the real-world learning targets (eg, the pillars in a temple or the objects in a museum) or interviewing the personnel in the field. The former aims to guide the students to acquire knowledge and gain experience via observing real-world targets, while the latter aims to help them obtain supplementary materials from the web. In addition, when students move to the particular locations marked with "an opportunity to win," they are asked to search for answers on the web to get additional points.

If the students move to a gaming location associated with a multiple-choice question, they are guided to the related real-world learning targets where they observe the targets to find the answer. When the students correctly answer a question, their scores are increased and shown on the learning interface. In addition, they can throw the dice again to move forward. After the students complete all of the learning tasks by correctly answering each question item or the learning time is due, the learning activity ends. Nevertheless, in case the students fail to correctly answer a question item, the learning system provides them with supplementary materials to guide them to find the correct answers.

In addition to the multiple-choice question tasks, when the students move to the locations named "an opportunity to win," the learning system presents information-searching tasks and asks them to search for answers on the Web to score additional points, as shown in Figure 3. The aim of the information-searching task is to help students learn to find supplementary materials on the web to complement what they have observed in the field.

Research design

To examine the performance of this innovative approach, an in-field local culture activity was undertaken in a temple in southern Taiwan. We aimed to help the elementary school students know about the local ancient assets in depth, and hence improve their local culture identity. As shown in Figure 4, the students learned with the peer competition-based m-learning system using tablet computers. When learning on the field, they were guided by the m-learning system to find the learning targets in the temple. After confirming their locations via scanning the QR codes, the students were guided to observe the learning targets for finding the answers to the questions raised by the m-learning system. They were also encouraged to search for information on the Web to answer the questions.

Participants

The participants were 57 fifth graders from two classes. One class that contained 29 students was assigned to be the treatment group; that is, they learned with the peer competition-based

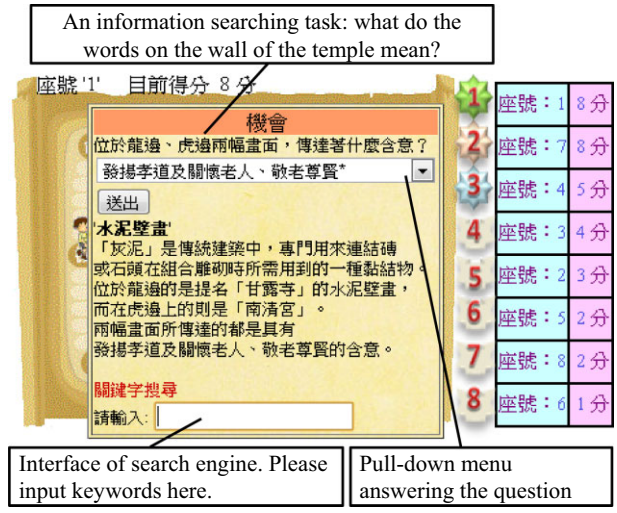

Figure 3: Interface of information-searching tasks

Figure 4: Scenarios of learning with the peer competition-based mobile learning system

m-learning system in the field trip. Another class, with 28 students, was the control group who learned with the conventional m-learning approach. It should be noted that all of the students in this study were guided by the m-learning system in the field to complete the learning tasks; moreover, they were taught by the same teacher and learned with the same learning materials via tablet computers.

Measuring tools

The research tools of this study included the questionnaires for measuring the students' "learning attitudes," "learning interest," "local culture identity" and "cognitive load."

The questionnaire of learning interest originated from the measure developed by Hwang and Chang (2011). It consists of six items, such as "I feel that learning local culture is interesting" and "I am interested in learning more about local culture," with a 7-point Likert rating mechanism. Its Cronbach's alpha value was 0.92.

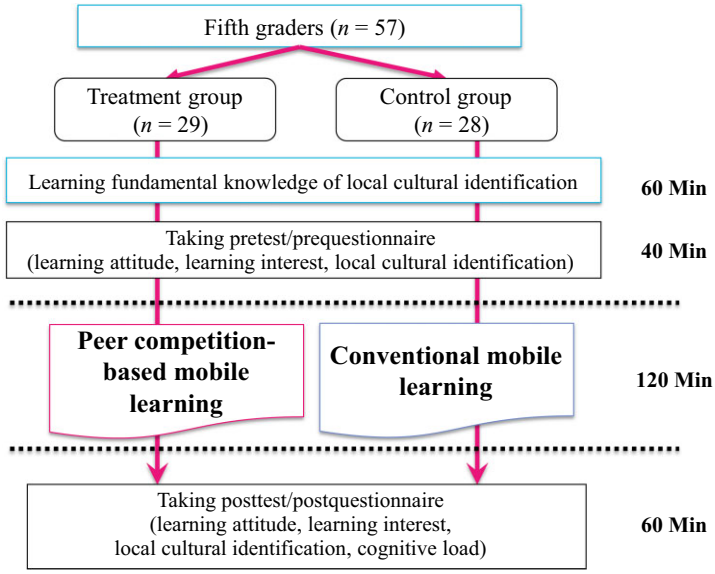

Figure 5: Experiment procedure

The learning attitude questionnaire also originated from the measure developed by Hwang and Chang (2011). There are seven items in the learning attitude questionnaire, such as "Local culture is a valuable course and is worth studying" and "I am interested in knowing more about the learning targets in the temple," with a 7-point Likert rating mechanism. Its Cronbach's alpha value was 0.88.

The questionnaire of local culture identity was from the measure developed by Hwang and Chang (2011). It consists of five items, such as "I think the hometown artifacts need to be preserved" and "I love to participate in my own hometown activities." The Cronbach's alpha value of the local culture identity questionnaire was 0.73.

The cognitive load measure originated from that developed by Sweller, Van Merriënboer and Paas (1998). It consists of four items in two dimensions; that is, two items for "Mental Load" (eg, "The learning contents are difficult for me"), and two items for "Mental Effort" (eg, "I think I need to spend a lot of effort learning the contents of the learning activities"). The Cronbach's alpha values of the two dimensions were 0.97 and 0.94, respectively.

Experiment procedures

Figure 5 shows the procedure of the experiment. The learning activity was a part of the existing social studies curriculum in the selected elementary school. Before the learning activity, the two groups of students had a 60-minute local culture lesson. Following that, they were asked to fill in the learning attitude, learning interest and local culture identity questionnaires.

During the learning activity, the treatment group students learned with the peer competition-based m-learning system approach. On the other hand, the control group students learned with the conventional m-learning approach. The two groups were both guided by the mobile learning system to complete the same set of learning tasks in the field. The time for the field trip was 120 minutes.

After the learning activity, the students were asked to fill in the learning attitude, learning interest, local culture identity and cognitive load questionnaires again.

Experimental results

Analysis of learning interest

Tables 1 and 2 show the descriptive statistics and the two-way ANOVA result of the students' learning interest. The mean values and standard deviations (*SD*) of the postquestionnaire ratings were 6.44 and 0.66 for the treatment group, and 5.55 and 1.01 for the control group. From the two-way ANOVA result, significant effects are found for both the learning approach ($F = 9.96$, $p = .003$) and Learning Interest ($F = 12.28$, $p = .001$). Moreover, the ANOVA result of the prequestionnaire ratings shows that there was no significant difference between the learning interests of the two groups ($F = 1.37$, $p > .05$) before the learning activity. This suggests that learning with the peer competition-based m-learning approach could promote the students' learning interest more than the conventional m-learning approach. Meanwhile, the analysis result also revealed that the students' learning interest ratings in the postquestionnaire were significantly higher than their prequestionnaire ratings, showing that the mobile technology-supported field trip could improve the learning interest of the students. As to the interaction between students' learning interest and learning approach, no significant effect was observed ($F = 2.75$, $p = .10$).

Analysis of learning attitude

In Tables 3 and 4, the descriptive statistics and the two-way ANOVA result of the students' learning attitude are given. The mean values and *SD*s of the learning attitude postquestionnaire ratings were 6.33 and 0.71 for the experiment group, and 5.58 and 1.03 for the control group. Significant effects were found for the learning approach ($F = 4.75$, $p = .03$), learning attitude ($F = 7.16$, $p = .01$) and the interaction between them ($F = 12.11$, $p = .001$) on the students' learning attitude ratings. The results indicate that learning with the peer competition-based m-learning system could improve the students' learning attitude more than the conventional m-learning approach. In addition, the analysis results also revealed that the students' learning attitude was significantly improved after participating in the learning activity.

A simple main-effect analysis was conducted to investigate the pre- and postquestionnaires on the learning attitude of the students who learned with different learning approaches (ie, mobile learning with or without the peer-competition mechanism). From the analysis results in Table 5,

Table 1: Descriptive statistics of the learning interest of the two groups

		Learning approach				
		Treatment group		*Control group*		
		n	Mean *(SD)*	n	Mean *(SD)*	*Marginal means*
Learning interest	Pretest ($n = 57$)	29	5.98 (1.01)	28	5.39 (1.05)	5.68 (0.14)
	Posttest ($n = 57$)	29	6.44 (0.66)	28	5.55 (1.01)	5.99 (0.11)
Marginal means		58	6.21 (0.16)	56	5.47 (0.17)	

Table 2: The two-way ANOVA result of the learning interest postquestionnaire ratings of the two groups

Variables	*SS*	df	*MS*	F	p
Learning approach	15.57	1	15.57	9.96	.003
Learning interest	2.77	1	2.77	12.28	.001
Learning interest × Learning approach	0.62	1	0.62	2.75	.10
Error	12.42	55	0.23		

Table 3: Descriptive statistics of the learning attitude of the two groups

		Learning approach				
		Treatment group		*Control group*		
		n	Mean *(SD)*	n	Mean *(SD)*	*Marginal means*
Learning attitude	Pretest ($n = 57$)	29	5.89 (0.88)	28	5.63 (1.00)	5.76 (0.13)
	Posttest ($n = 57$)	29	6.33 (0.71)	28	5.58 (1.03)	5.96 (0.12)
Marginal means		58	6.11 (0.16)	56	5.61 (0.17)	

Table 4: The two-way ANOVA result of learning attitude

Variables	*SS*	df	*MS*	F	p
Learning approach	7.17	1	7.17	4.75	.03
Learning attitude	1.05	1	1.05	7.16	.01
Learning attitude × Learning approach	1.77	1	1.77	12.11	.001
Error	7.90	54	.17		

Table 5: Simple main-effect analysis results of learning approaches on students' learning attitude

Variables	*SS*	df	*MS*	F
Learning approach (Factor A)				
Peer competition-based mobile learning system approach	2.87	1	2.87	17.76***
Conventional mobile learning approach	0.05	1	0.05	0.35
Learning attitude (Factor B)				
Pretest	0.91	1	0.91	1.02
Posttest	8.64	1	8.64	11.35**

**$p < .01$; ***$p < .001$.

it was found that the treatment group students had significantly better learning attitude than the control group students ($F = 17.76$, $p < .001$). Moreover, a significant difference was found between the learning attitude postquestionnaire ratings of the two groups ($F = 11.35$, $p < .01$), while no significant difference was found between their pre-questionnaire ratings.

Figure 6 further shows the interaction between the learning approach and the learning attitude of the students before and after the learning activity. It is concluded that the students who learned with the peer competition-based m-learning system made significant improvement on learning attitude compared with those who learned with the noncompetition-based m-learning approach.

Analysis of local culture identity

Tables 6 and 7 show the descriptive statistics and the two-way ANOVA result of the students' local culture identity. From the experimental results, it was found that the mean values and *SD*s of the postquestionnaire ratings were 6.66 and 0.47 for the experiment group, and 5.89 and 0.97 for the control group. A significant effect was found for the learning approach ($F = 11.14$, $p = .002$); that is, the students who learned with the peer competition-based m-learning approach had significantly higher local culture identity than those who learned with the conventional mobile learning approach. Moreover, the ANOVA result of the prequestionnaire ratings showed that there was no significant difference between the local culture identity ratings of the two groups

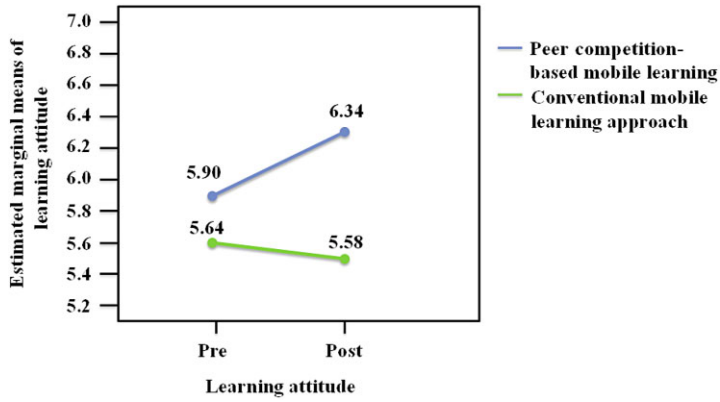

Figure 6: Interaction between learning attitude and learning approach

Table 6: Descriptive data of the local culture identity of the two groups

		Learning approach				
		Treatment group		*Control group*		
		n	Mean (SD)	n	Mean (SD)	*Marginal means*
Local culture identity	Pretest ($n = 57$)	29	6.50 (0.53)	28	6.04 (0.89)	6.27 (0.10)
	Posttest ($n = 57$)	29	6.66 (0.47)	28	5.89 (0.97)	6.28 (0.10)
Marginal means		58	6.58 (0.13)	56	5.96 (0.13)	

Table 7: The two-way ANOVA result of the local culture identity

Variables	*SS*	df	*MS*	F	P
Learning approach	10.90	1	10.90	11.14	.002
Local culture identity	0.02	1	0.02	0.01	.91
Local culture identity × Learning approach	0.65	1	0.65	4.97	.30
Error	7.17	55	0.13		

($F = 1.41$, $p > .05$) before the learning activity. This suggests that the peer competition-based m-learning approach promoted the students' local culture identity more than the conventional m-learning approach.

Analysis of cognitive load

In terms of cognitive load, the mean values and *SD*s were 3.51 and 1.53 for the control group, and 2.65 and 1.32 for the treatment group. The *t*-test result ($t = -2.28$, $p < .05$) shows that there was significant difference between the two groups, as shown in Table 8. That is, the students who learned with the conventional mobile learning approach revealed significantly higher cognitive load than those who learned with the peer competition-based mobile learning approach, implying that the competition mechanism was able to decrease the students' cognitive load on the field trip.

The correlations between learning interests, attitude, local cultural identity and cognitive load are given in Table 9. It was found that there were positive correlations between the students'

Table 8: t-Test result of the cognitive load ratings

Group	n	Mean	SD	t
Treatment group	29	2.65	1.32	−2.28*
Control group	28	3.51	1.53	

*$p < .05$.

Table 9: Correlations between learning interests, attitude, local cultural identity and cognitive load

Treatment group	*Learning interests*	*Learning attitude*	*Local cultural identity*	*Cognitive load*
Learning interests	1			
Learning attitude	0.91**	1		
Local cultural identity	0.84**	0.85**	1	
Cognitive load	−0.19	−0.18	−0.29*	1

*$p < .05$; **$p < .01$.

learning interests, attitude and local cultural identity. This implies that, owing to the peer-competition approach, the students' learning interests were significantly promoted, which could be the reason why the treatment group students' learning attitudes and local identity were better than those of the control group students. On the other hand, the students' cognitive load was negatively correlated with local cultural identity, showing that reducing students' cognitive load could be another important factor for improving their affective domain exhibition.

Interview results

After the experiment, five students (E1, E2 . . . E5) were randomly selected from the treatment group for interviews. The interview questions were "What are the main differences between this m-learning activity and previous learning activities you have participated in? What are the advantages or disadvantages of the present m-learning approach?," "Would you like to learn with such a mobile learning approach in the future? Which courses would you like to learn with this approach?" and "Would you recommend that other teachers adopt this learning approach?"

When asked about the differences between the peer competition-based m-learning approach and the other m-learning approaches, all five students shared a consistent perspective that they considered "encouraging learning" and "promoting affective feelings" as the main benefits provided by the peer-competition approach.

From the viewpoint of "encouraging learning," three students indicated that the peer-competition approach made them more willing to learn as competing with peers was interesting and exciting. For example, student E3 stated that, "During the learning process, I competed with peers to see who could find the answers to questions more efficiently. This is not only fun, but it also makes me learn a lot about the learning tasks." E4 pointed out that, "On previous field trips, I often failed to concentrate on the learning tasks, while in this learning activity, I paid full attention to the learning tasks because competing with peers was interesting."

From the perspective of "promoting affective feelings," four students expressed the same feeling; that is, after knowing the details of the temple, they began to feel interested in those ancient assets and stories and would like to know more about local culture. For example, E1 stated that, "During the peer competition process, I learned the representative meaning of the stone lions in the temple, which attracted my interest in knowing more about the allusion of everything in the temple." E3 also shared a similar experience: "Now I know the significance of the lions in

the temple. I didn't realize that everything in the temple was so interesting till now." E2 indicated that, "Now I know there are many interesting things in the temple and would like to learn more about them." E4 stated that, "After participating in this competitive activity, I find that there are many gods in the temple. The studies of these gods interest me."

All five students expressed their willingness to learn with the same approach in the future. In addition, three students stated that they hoped that such a peer-competition strategy can be adopted in other courses. E1 stated that, "I hope that similar activities can be conducted in the English course since the course is too difficult for me to learn. Using this competition method might resolve the problem." E2 shared a similar feeling about learning mathematics. He indicated that, "I hope that the same activity can be conducted in the mathematics course since it is difficult. I would be willing to learn mathematics in this way." E3 stated that, "I think the same approach can be used in the Chinese course since I can never concentrate on the learning process in that course."

Finally, all of the students indicated that they would like to recommend the peer competition-based m-learning approach to peers and teachers. For example, E1 stated that, "I would recommend the m-learning activity to the students I know in other classes. Such a learning approach is really interesting and exciting." He also indicated that, "I think other teachers also need to know this approach, which can make students more willing to learn." E5 shared similar feelings. E2 stated that, "I will recommend this approach to others since it helped me learn every detail of the course content in an enjoyable manner." E4 indicated that, "I would recommend this activity to my family. I would also like to bring my family to visit the temple and share my experience with them." From these interview results, it is found that the peer competition-based m-learning approach successfully promoted the students' affective domain exhibition.

Discussion and conclusions

In this paper, a peer competition-based m-learning approach is proposed for supporting local culture learning activities. An experiment was carried out to compare the learning performances of the students who were situated in the proposed m-learning environment and those situated in the conventional m-learning environment.

From the experimental results, it is found that the peer competition-based m-learning approach significantly improved the students' learning interest, attitude and local cultural identity more than the conventional m-learning approach did; moreover, it is also found that the peer competition-based m-learning approach decreased the students' cognitive load more in comparison with the conventional m-learning approach.

While most mobile learning studies have focused on the issue of improving students' learning achievements from the cognitive dimension (Chu, 2014; Huang, Liao, Huang & Chen, 2014; Kiger, Herro & Prunty, 2012), one of the primary contributions of the present study is the proposal of the peer competition-based m-learning approach that aims at improving students' affective domain exhibition, including learning interest, attitudes and local cultural identity. Another contribution is the interesting findings of this study. That is, incorporating the features of peer competition into mobile learning activities not only enhanced the students' interests, attitudes and local cultural identity, but also reduced their cognitive load on the field trip. Although some previous studies have reported that challenges and competitions can encourage students to learn in an enjoyable manner in the virtual world (Reinecke *et al*, 2012; Ryan, Rigby & Przybylski, 2006), few studies have investigated the effectiveness of peer competition on field trips, not to mention the effects of the peer competition-based m-learning approach on students' affective exhibition. In particular, the finding that peer competition can reduce students' cognitive load on field trips is not obvious. The competitive nature usually causes pressure; however, in this

study, the peer-competition strategy was employed with well-designed problem-based tasks and instant feedback, which could be the reason why the students' cognitive load was decreased. Such a finding is a good reference for the researchers or school teachers who plan to conduct mobile learning activities with competition strategies in the future.

On the other hand, it should be noted that such an experimental result is not apparent. In fact, several previous studies have reported unexpected or disappointing results of mobile learning, owing to improper learning design. For example, Chu (2014) reported the negative effects of mobile learning for a social studies course. In that study, the treatment group students' cognitive loads were significantly increased, and hence their learning performances were disappointing. Therefore, to incorporate competition features into mobile learning activities, careful design is necessary to enable students to learn enjoyably and meaningfully. In this study, the peer competition-based m-learning group had significantly lower cognitive load than the conventional m-learning group, showing that the integration of mobile learning and competition strategy was successful.

Although the application of this study was the "local culture" unit in a social studies course, the proposed approach can be applied to the in-field activities of other units or courses, such as natural science courses, history courses and geography courses, by modifying the learning tasks and supplementary materials in the databases. Moreover, to make the learning activities more interesting, some learning tasks in the "an opportunity to win" locations can be replaced by quizzes or small educational games. Therefore, it is worth extending the present approach and applying it to more application domains.

In the future, we plan to apply the similar approach to the "plant identification" and "butterfly ecology" units of natural science courses. Moreover, the effects of the approach on the students with different cognitive styles and knowledge levels will be investigated from both the cognitive and affective dimensions. It is expected that from those in-depth evaluations and discussions, more effective technology-enhanced learning methods or systems can be developed, and well-defined leading-in procedures can be provided for the reference of both researchers and teachers.

Acknowledgements

This study is partially supported by the Ministry of Science and Technology of Taiwan under contract number NSC 102-2511-S-011-007-MY3.

Statements on open data, ethics and conflict of interest

The authors are pleased to provide the experimental data upon request.

The subjects of this study were protected by hiding their personal information during the learning activity; moreover, participating in the experiment was voluntary and would not affect their grades. In addition, the subjects were allowed to withdraw from the experiment at any stage.

The authors would like to state that there is no potential conflict of interest in this study.

References

Admiraal, W., Huizenga, J., Akkerman, S. & Dam, G. T. (2011). The concept of flow in collaborative game-based learning. *Computers in Human Behavior*, *27*, 3, 1185–1194.

Burguillo, J. C. (2010). Using game theory and competition-based learning to stimulate student motivation and performance. *Computers & Education*, 55, 2, 566–575.

Charitonos, K., Blake, C., Scanlon, E. & Jones, A. (2012). Museum learning via social and mobile technologies: (how) can online interactions enhance the visitor experience? *British Journal of Educational Technology*, *43*, 5, 802–819.

Chen, C. C. & Huang, T. C. (2012). Learning in a u-Museum: Developing a context-aware ubiquitous learning environment. *Computers & Education*, 59, 3, 873–883.

Chen, C. P., Shih, J. L. & Ma, Y. C. (2014). Using instructional pervasive game for school children's cultural learning. *Educational Technology & Society*, *17*, 2, 169–182.

Chen, Z. H. (2014). Exploring students' behaviors in a competition-driven educational game. *Computers in Human Behavior*, *35*, 68–74.
Chu, H. C. (2014). Potential negative effects of mobile learning on students' learning achievement and cognitive load-a format assessment perspective. *Educational Technology & Society*, *17*, 1, 332–344.
Crowe, A. R. (2004). Teaching by example- integrating technology into social studies education courses. *Journal of Computing in Teacher Education*, *20*, 4, 159–165.
Deutsch, M. (1973). *The resolution of conflict: constructive and destructive processes*. New Haven, CT: Yale University Press.
Dolgov, I., Graves, W. J., Nearents, M. R., Schwark, J. D. & Brooks Volkman, C. (2014). Effects of cooperative gaming and avatar customization on subsequent spontaneous helping behavior. *Computers in Human Behavior*, *33*, 49–55.
Franklin, T. (2011). Mobile learning: at the tipping point. *The Turkish Online Journal of Educational Technology*, *10*, 4, 261–275.
Fu, F. L., Wu, Y. L. & Ho, H. C. (2009). An investigation of coopetitive pedagogic design for knowledge creation in web-based learning. *Computers & Education*, *53*, 3, 550–562.
Gedik, N., Hanci-Karademirci, A., Kursun, E. & Cagiltay, K. (2012). Key instructional design issues in a cellular phone-based mobile learning project. *Computers & Education*, *58*, 4, 1149–1159.
Hemmi, A., Narumi-Munro, F., Alexander, W., Parker, H. & Yamauchi, Y. (2014). Co-evolution of mobile language learning: going global with games consoles in higher education. *British Journal of Educational Technology*, *45*, 2, 356–366.
Huang, Y. M., Liao, Y. W., Huang, S. H. & Chen, H. C. (2014). A jigsaw-based cooperative learning approach to improve learning outcomes for mobile situated learning. *Educational Technology & Society*, *17*, 1, 128–140.
Hwang, G. J. & Chang, H. F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education*, *56*, 1, 1023–1031.
Hwang, G. J., Wu, P. H., Zhuang, Y. Y. & Huang, Y. M. (2013). Effects of the inquiry-based mobile learning model on the cognitive load and learning achievement of students. *Interactive Learning Environments*, *21*, 4, 338–354.
Hwang, G. J., Hung, P. H., Chen, N. S. & Liu, G. Z. (2014). Mindtool-Assisted In-Field Learning (MAIL): an advanced ubiquitous learning project in Taiwan. *Educational Technology & Society*, *17*, 2, 4–16.
Hwang, G.-J., Tsai, C.-C. & Yang, S. J.-H. (2008). Criteria, strategies and research issues of context-aware ubiquitous learning. *Educational Technology & Society*, *11*, 2, 81–91.
Hwang, M. Y., Hong, J. C., Cheng, H. Y., Peng, Y. C. & Wu, N. C. (2013). Gender differences in cognitive load and competition anxiety affect 6th grade students' attitude toward playing and intention to play at a sequential or synchronous game. *Computers & Education*, *60*, 1, 254–263.
Hwang, W. Y. & Su, J. H. (2012). The study of surface computer supported cooperative work and its design, efficiency, and challenges. *Interactive Learning Environments*, *20*, 2, 177–198.
Kearney, M., Schuck, S., Burden, K. & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. *Research in Educational Technology*, *20*, 1, 1–17.
Kiger, D., Herro, D. & Prunty, D. (2012). Examining the influence of a mobile learning intervention on third grade math achievement. *Journal of Research on Technology in Education*, *45*, 1, 61–82.
Klopfer, E., Sheldon, J., Perry, J. & Chen, V. H. (2012). Ubiquitous games for learning (UbiqGames): weatherlings, a worked example. *Journal of Computer Assisted Learning*, *28*, 5, 465–476.
Lin, C. P., Wang, Y. J., Tsai, Y. H. & Hsu, Y. F. (2010). Perceived job effectiveness in coopetition: a survey of virtual teams within business organizations. *Computers in Human Behavior*, *26*, 6, 1598–1606.
Liu, T. Y. & Chu, Y. L. (2010). Using ubiquitous games in an English listening and speaking course: Impact on learning outcomes and motivation. *Computers & Education*, *55*, 2, 630–643.
Looi, C. K., Sun, D., Wu, L., Seow, P., Chia, G., Wong, L. H. *et al* (2014). Implementing mobile learning curricula in a grade level: empirical study of learning effectiveness at scale. *Computers & Education*, *77*, 101–115.
Martin, F. & Ertzberger, J. (2013). Here and now mobile learning: an experimental study on the use of mobile technology. *Computers & Education*, *68*, 76–85.
Nonaka, I., Umemoto, K. & Sasaki, K. (1998). Managing and measuring knowledge in organizations. In G. von Krogh, J. Roos & D. Kleine (Eds), *Knowledge in firms: understanding, managing and measuring knowledge* (pp. 146–172). Thousand Oaks, CA: Sage.
Ogata, H., Li, M., Hou, B., Uosaki, N., El-Bishouty, M. & Yano, Y. (2011). SCROLL: supporting to share and reuse ubiquitous learning log in the context of language learning. *Research and Practice in Technology Enhanced Learning*, *6*, 2, 69–82.

Pe-Than, E. P. P., Goh, D. H. L. & Lee, C. S. (2014). Making work fun: investigating antecedents of perceived enjoyment in human computation games for information sharing. *Computers in Human Behavior, 39*, 88–99.
Peng, W. & Hsieh, G. (2012). The influence of competition, cooperation, and player relationship in a motor performance centered computer game. *Computers in Human Behavior, 28*, 6, 2100–2106.
Reinecke, L., Tamborini, R., Grizzard, M., Lewis, R., Eden, A. & David Bowman, N. (2012). Characterizing mood management as need satisfaction: the effects of intrinsic needs on selective exposure and mood repair. *Journal of Communication, 62*, 3, 437–453.
Ryan, R. M., Rigby, C. S. & Przybylski, A. (2006). The motivational pull of video games: a self-determination theory approach. *Motivation and emotion, 30*, 4, 344–360.
Sánchez, J. & Olivares, R. (2011). Problem solving and collaboration using mobile serious games. *Computers & Education, 57*, 3, 1943–1952.
Sandberg, J., Maris, M. & Hoogendoorn, P. (2014). The added value of a gaming context and intelligent adaptation for a mobile learning application for vocabulary learning. *Computers & Education, 76*, 119–130.
Sharples, M. (2009). Methods for evaluating mobile learning. In G. N. Vavoula, N. Pachler & A. Kukulska-Hulme (Eds), *Researching mobile learning: frameworks, tools and research designs* (pp. 17–39). Oxford: Peter Lang Publishing Group.
Skon, L., Johnson, D. W. & Johnson, R. T. (1981). Cooperative peer interaction versus individual competition and individualistic efforts: effects on the acquisition of cognitive reasoning strategies. *Journal of Educational Psychology, 73*, 1, 83–92.
Sung, H. Y., Hwang, G. J., Liu, S. Y. & Chiu, I. H. (2014). A prompt-based annotation approach to conducting mobile learning activities for architecture design courses. *Computers & Education, 76*, 80–90.
Sweller, J., Van Merrienboer, J. J. & Paas, F. G. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*, 3, 251–296.
Tan, G. W. H., Ooi, K. B., Leong, L. Y. & Lin, B. (2014). Predicting the drivers of behavioral intention to use mobile learning: a hybrid SEM-Neural Networks approach. *Computers in Human Behavior, 36*, 198–213.
Wong, L. H., Hsu, C. K., Sun, J. & Boticki, I. (2013). How flexible grouping affects the collaborative patterns in a mobile-assisted Chinese character learning game. *Educational Technology & Society, 16*, 2, 174–187.
Yang, G., Chen, N. S., Sutinen, E., Anderson, T. & Wen, D. (2013). The effectiveness of automatic text summarization in mobile learning contexts. *Computers & Education, 68*, 233–243.