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Detecting the correlation between mobile learning behavior and personal characteristics among elementary school students

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ABSTRACT

This study aimed to explore the features of mobile learning behaviors among Chinese elementary school students, and relationships between mobile learning behaviors and personal characteristics in mobile learning environment. The current study designed and developed a game-based educational mobile environment and conducted an experimental research. Eighty-three elementary students participated in this study. The results revealed the features of elementary school students' mobile learning behavior including: 1) the students had reasonable login frequencies and learning time duration with appropriate guidance from the teachers, and satisfying learning performance by self-learning; 2) higher grade, learning style with active information processing and higher test scores in the conventional Chinese subject course had positive impacts on the mobile learning behaviors, but no gender difference was found. Regrettably, students showed more digital consuming than digital creating in the current study. The results could provide necessary suggestions on mobile learning for young learners.

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KEYWORDS
Mobile learning environment; mobile learning behavior; elementary students; blended learning; personal characteristics

1. Introduction

Undoubtedly, elementary school students had different learning characteristics and process from the adults (García, Rodríguez, González-Castro, González-Pienda, & Torrance, 2016), especially born after 2000 entitled "digital natives" (Prensky, 2001; Thompson, 2013). Mobile had merged into the digital natives' life compared with the eldership. Therefore, many countries had introduced mobile technologies into formal academic courses to keep pace with the development of the students' characteristic and the digital era (Crompton & Burke, 2015; Liu & Chu, 2010; Lys, 2013; Wu et al., 2012).

However, knowledge about mobile learning features of young students had fallen behind the rapid development of mobile hardwires and wireless network (Land & Zimmerman, 2015). Although some researches had explored effects of mobile learning system or pedagogies on academic achievement among elementary students (Chu, 2014; Ciampa, 2014; Hsieh, Lin, & Hou, 2016; Huang, Lin, & Cheng, 2010), but what are the elementary students' features of the mobile learning behaviors? What are the relationships between personal characteristics and mobile learning behaviors' features? To explore the issues that are still unclear, our research team designed a mobile learning environment for an elementary school level academic course. This study aims to

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examine the features of mobile learning behaviors, academic performance and the relationships with students' personal characteristics in academic course learning in school among Chinese elementary students.

The two research questions are specified as follows:

1) What are the features of mobile learning behavior among the elementary school students?
2) What are the relationships between mobile learning behavior, academic performance and personal characteristics in mobile learning environment?

2. Literature review

2.1. Mobile learning in elementary schools

The advancement of mobile technologies has encouraged an increasing number of studies concerning mobile learning in elementary school level (Chu, 2014; Hsieh et al., 2016; Huang & Chiu, 2015). According to a meta-analysis about the trends of mobile learning from 2003–2010, most studies about mobile learning focus on effectiveness, followed by mobile learning system design, surveys and experiments were used as the primary research methods (Wu et al., 2012). Another systematic review of 36 studies in mobile learning in mathematics from the year 2000 to 2015 showed that the elementary school settings and formal educational contexts were the most common research context, mobile phones were the most often used mobile device (Crompton & Burke, 2015). The two collective understanding of mobile learning in the elementary-school-level revealed that formal academic course integrating with mobile learning system, such as digital textbooks, mobile educational applications, and learning platforms, had become the basis for evaluating the affordances of mobile learning in the past decade. In general, evaluation of mobile learning in elementary schools focused on two major perspectives.

2.1.1. Academic performance

Mobile technologies had been introduced into classroom to conduct technology-enhanced face-to-face instruction in elementary schools (Sun & Luo, 2015; Sun & Jiang, 2015). As a forementioned system review about mobile learning, academic performance improvement was mainly reported in most of the primary worldwide researches (Crompton & Burke, 2015; Furió, Juan, Seguí, & Vivó, 2015; Wu et al., 2012). For example, mobile systems had been proved to significantly increase students' learning performance on English (Liu & Chu, 2010; Tan & Liu, 2004), science (Huang et al., 2010), socio-technical (Land & Zimmerman, 2015) and biology (Hwang & Shih, 2015) compared with the conventional learning manner. Since school is the major learning setting for elementary students, academic performance gains continuous attention in nowadays and the coming decade.

2.1.2. Non-academic performance

Although many researches have demonstrated benefits of mobile learning in helping students improving academic performance in school settings, educators have proposed the importance of promoting non-academic performance as well, such as learning interest (Tan & Liu, 2004), self-efficacy (Hwang & Shih, 2015) and attitude (Chen, 2015; Hwang & Chang, 2011). For instance, mobilized science curriculum improved elementary school students' activity performance (Sun, Looi, Wu, & Xie, 2016). Mobile learning system incorporating with gamification technologies into botanical learning process helped students achieve higher degree of motivation than conventional instruction (Su & Cheng, 2015).

Based on the proved positive impacts of mobile learning system or pedagogies on elementary students' learning performance, young learners' personal characteristics in the emerging learning environment attracted more attention from researchers.

2.2. Personal characteristics in mobile learning performance

Many scholars investigated whether there are differences in mobile learning academic performance and students' personal characteristics such as gender, grade, and learning style.

2.2.1. Demographics

Gender and grade are common demographic factors to explore potential different impacts on learning outcomes. Some studies showed that no significant gender differences in scores (Gwee, Chee, & Tan, 2011) and the quality of student works in mobile curriculum (Gwee, Tan, & Jan, 2014). However other studies reported opposite result that gender difference exists in academic performance scores (Bolliger & Supanakorn, 2011; Hsieh, Lin, & Hou, 2016; Liu, Hwang, & Chen, 2015), and mobile behaviors (Huang, Liang, & Chiu, 2013). Grade difference was founded in mobile learning scores of the elementary level course in some researches (Hsieh et al., 2016; Wen, Cheng, Chen, & Hsieh, 2013) that students of higher grades had significantly higher scores in both performance and flow experience than students of lower grade. Although the results are diverse due to difference learning contents and geographic locations, but agreement had been reached that demographics of the digital natives should be concerned in mobile learning (Huang et al., 2013; Wen et al., 2013).

2.2.2. Learning style

An individual's learning style is defined as the methods or strategies that he or she uses to learn. Learning styles have been defined using several approaches including how learners select information (neuro/linguistic programing), how they process information (logically/holistically) or how they structure and use information (Kolb, 1984). Of various models of learning styles in the literature, the study of Felder and Silverman has been used effectively in numerous studies (Graf, Viola, Leo, & Kinshuk, 2007; Huang, Lin, & Huang, 2012), who proposed four dimensions to describe the learning style: (1) active or reflective on information processing, (2) sensory or intuitive on information perceiving, (3) visual or verbal on information presenting and (4) sequential or global on information understanding. Some studies have focused on how learning styles influence learner performance in online (Bolliger & Supanakorn, 2011 ; Cela, Sicilia, & Sánchez-Alonso, 2016; Cha et al., 2006) and mobile learning environment (Sun, Lin, & Yu, 2008). Since the results are diverse, consistent view was that students would achieve higher academic performance and perceived more satisfying experience (Chen & Chiou, 2014), less cognitive load (Abdul-Rahman & Du Boula, 2014) if the designer takes students' learning style into consideration (Cela et al., 2016).

Since gender, age and learning style had been regarded as useful personal characteristics for evaluating mobile learning outcomes of elementary students, most of studies ignored to consider potential relationships between student learning performance and mobile learning behaviors. With the inevitable tendency of blended learning in elementary school (Hwang & Shih, 2015), students' mobile learning behaviors should be taken into consideration as indicators for effective mobile learning.

2.3. Mobile learning behavior

The purpose of exploring learning behavior is observing naturally occurring behaviors in naturalistic contexts (Bakeman & Gottman, 1997) to conclude what they are doing, why they are doing, and what kind of behavior pattern could improve learning performance. Therefore, the sequence and frequency of behaviors during learning process in technology-based learning contexts are used most often in mobile social-network-based education practice (Wu, 2014), in cooperative translation online system (Yang, Li, Guo, & Li, 2015), in virtual learning community (Tobarra, Robles-Gómez, Ros, Hernández, & Caminero, 2014), and in adaptive network (Chen & Sayed, 2015). However, elementary students had weaker informational expertise to communicate in online discussion forum, or use

multi-functional interface system, as they had different behavior features compared with adult learners, therefore different analysis focuses should be conducted for young learners. For instance, Gwee et al. (2011) observed digital learning time as an indicator to compare what the effects of gender behavior difference impact on the scores in mobile-based course. Hwang, Liu, Chen, Huang, and Li (2015) considered the interaction with mobile system as learning behaviors to discuss the relationships with the achievement. Gwee et al. (2014) detected students' digital play game and the quality of student work to address the level of students' learning participation in mobile game-based social studies curriculum. In generally, the digital learning time, quality of student work and interactions with the mobile system are common indicators of mobile learning behavior for elementary student.

To conduct this study, we designed a specific game-based educational mobile application for iPad, named as Blended Curriculum Book (BC-Book), to provide an environment for knowledge learning of Chinese mid-autumn festival culture to help students get preparation for face-to-face culture learning (The APP is presented in detail in the method section of the paper). The database of BC-Book could record each user's login time, learning duration, and correct rate while interacting with the app via embedded game-like test and the products they uploaded. As a consequence, the current study located login frequencies in mobile learning system, learning time duration, correct rate of playing game-like test and students' digital work, as indicators to evaluate mobile learning behaviors for young learners in elementary schools.

3. Method

3.1. Participants

The participants in this study were 83 elementary school students (39 girls, 44 boys) in Beijing, China. Their age ranged from 8 to 13 years with an average age of 10.08 (SD = 1.21). Among them, 18 students (21.7%) were third-graders, 44 (53%) were fifth-graders and 21 (25.3%) were sixth-graders. They all had traditional culture courses about the Chinese Mid-autumn festival. A teacher from the school explained the intention of the study to the students and parents and then recruited 83 participants. According to their self-report, 76 (91.6%) participants had mobile learning experience with iPad over two years.

3.2. The mobile learning environment

The students are situated in both the real world and the virtual world to extend their learning experiences about Chinese traditional culture in the current study. To provide a mobile learning environment and collect footprint of mobile learning behaviors, a game-based application (APP) for iPads, BC-Book, was developed in the study.

The BC-Book was constructed by JAVA for the website, MySQL for the database, and Xcode for the iPad2 devices. The system consists of three architectural layers, as shown in Figure 1. The processing data for different tasks is packaged in the data layer. The control layer included user center, learning resources and game resource. The controller layer made different tasks reusable. The task layer run the subtasks and actions. The interface layer described the graphic user interfaces by receiving data from the control layer.

The APP consists of three functional modules as game, task and user center. The game module encouraged students to answer questions about the Chinese festival culture with a game rewarding mechanism, as shown in Figure 2. Actually, the game module contained necessary knowledge of Chinese culture. If participants answer questions about specific knowledge correctly, they could move to next step in the game module. If they failed to make the right choice, the system will provide an explanation about the specific knowledge in text, picture or video recorded by teachers in advance. The task module guided students to upload their digital products of six actual tasks in real

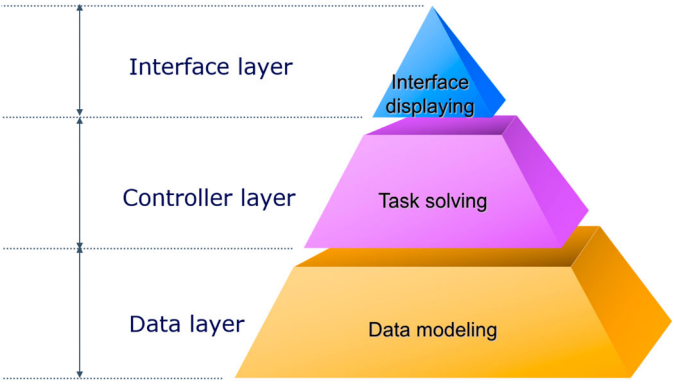

Figure 1. Architectural layers of the system.

Figure 2. Screenshot of game module.

life, as shown in Figure 3. The tasks are making moon cakes, poem recitation, making Lord Rabbit, making lunar chiaroscuro, making e-greeting card and taking pictures of the moon. The task module of the BC-Book provides several videos or help documents in text-formatting if the students had troubles in understanding or accomplishing tasks.

The user center module displayed users' personal information and learning progress with visualized interface, as shown in Figure 4.

3.3. Procedure

The experiment was from September to October in 2015. Before the experiment, our research team conducted a survey to get the participants' personal demographics, measure their learning styles. Then the students accessed to BC-Book for mobile learning.

Figure 3. The screenshot of six tasks.

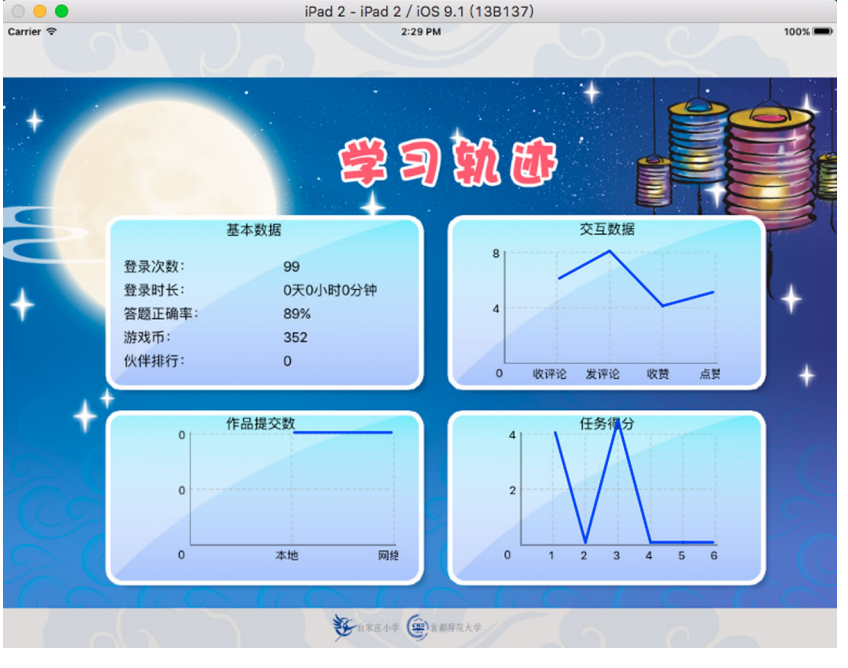

Figure 4. The screenshot of user center area.

In traditional teaching plan, the learning unit would last for four weeks with 40-minute lesson each week, mainly by teacher-centered explanation about Chinese festival culture. In the current study, students occupied the same period for mobile learning without teacher lecturing

Figure 5. Students in the experiment.

anymore. They explored relative knowledge in their own paces with BC-Book. In another word, students had full authority to determine what, how long, how many times and how to learn with mobile devices as Figure 5 shown. Students' digital tracks of mobile learning behaviors were recorded by the BC-Book for further analysis. The role of teacher was to distribute and take back the iPads, provide necessary guidance if needed. The research procedure is shown in the Figure 6.

3.4. Instruments

3.4.1. Personal characteristics

For the purposes of the investigation, we used a demographic questionnaire to get students' profiles about name, age, gender, grade, and mobile learning experience with smart phones and Pads. Additionally, we collected the 83 students' final exams scores of three conventional courses in last term, Math, Chinese and English to answer the second research question.

3.4.2. Learning style

We used the inventory of learning styles (ILS) in order to measure students' learning style. Felder and Silverman's (1988) work identified a typology of learning styles and used 44 dichotomous questions to analyze four dimensions: (1) how information is processed (active–reflective), (2) how information is perceived (sensory–intuitive), (3) how information is presented (visual–verbal) and (4) how information is understood (sequential–global).

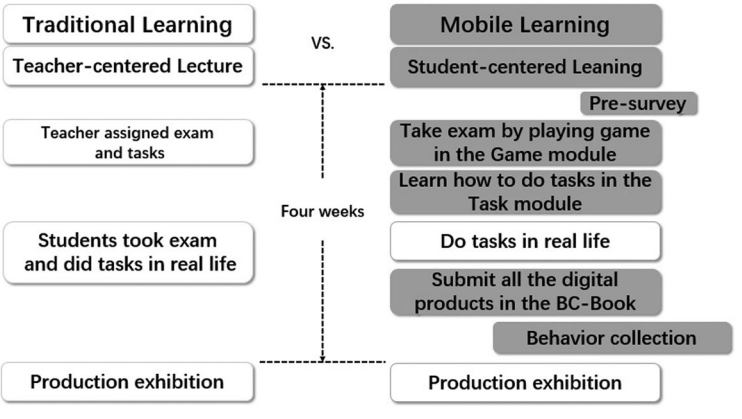

Figure 6. Research Procedure.

Before the experiment, the participants filled out the paper questionnaire about ILS. Results were analyzed based on the responses from 83 individuals.

3.4.3. Logs

During the mobile learning process, the interactions of students with the BC-Book were logged in the database of the app for statistical analysis. For each student, the logged events including: (1) login frequency; (2) learning time duration; (3) correct answer rate of answering questions in the game module in the BC-Book; (4) the number of digital products submitted in the task module in the BC-Book. And for each teaching video in the task module, the CTR (click-through rate) was logged as well.

3.5. Data analysis

After reclamation of the completed questionnaires and logs, data was initially processed using Excel ver. 2010. After that, to answer the first research question, the descriptive and correlations statistics of iPad-based learning behaviors were conducted by SPSS ver. 19. Meanwhile, T-test, ANOVA and correlation analysis were conducted to explore the second research question.

4. Results

4.1. Features of mobile learning behaviors among elementary students

4.1.1. Descriptive statistics results of mobile learning behaviors

To detect characteristics of mobile learning behaviors, we conducted descriptive statistics analysis including frequencies of login, mobile learning time duration, correct rate of answering questions and number of digital products submitted, as shown in Table 1. According to the results, all the students ($N = 83$) have learned with the BC-Book about 6.90 times in four weeks. The mean learning time duration of each student is 36.44 min. It means that the students fully engaged in the self-mobile-learning with the BC-Book in the 40-minute lesson, even they had the authority to do other things. The average correct answer rate is 0.71. In addition, average of digital products submitted in the task module is 1.81. However, the products were only from 39 out of 83 students.

4.1.2. Relationships among different mobile learning behaviors

To explore the relationships among different mobile learning behaviors, we performed Pearson correlation analysis involving three variables, as shown in Table 2. According to the results, the frequencies of login and learning time duration have significant close relationships with students' correct answer rate ($r = 0.591$; $p = 0.000$; $r = 0.269$; $p = 0.015$) respectively. These findings suggest that students who used BC-Book with higher frequency and longer duration achieved better learning effects on knowledge construction about the culture. No significant correlations between the digital products submitted in the BC-Book with other three variables.

4.1.3. Popularity of course videos

Table 3 shows the popularity of six teaching videos in the task module of BC-Book system, including making moon cakes, poesy recitation, making Lord Rabbit, making phase diagram, making e-greeting card and taking pictures of the moon. The teachers produced videos in advance to guide the learners

Table 1. The descriptive statistics results of learning behaviors.

$N = 83$	M	SD
Frequency of login	6.90	5.7
Learning time duration	36.4	32.3
Correct answer rate	0.71	0.16
Number of products submitted	1.81	3.13

Table 2. The correlations among learning behaviors.

	Frequency of login	Learning time duration	Correct answer rate	Number of products submitted
Frequency of login	–			
Learning time duration	.169	–		
Correct answer rate	.591**($p = 0.000$)	.269*($p = 0.015$)	–	
Number of products submitted	.033	−.015	−.218	–

*$p < 0.05$
**$p < 0.01$.

Table 3. The CTR of each course video.

	Course video	CTR
1	Making moon cakes	54
2	Poesy recitation	52
3	Making Lord Rabbit	47
4	Making phase diagram	47
5	Making e-greeting card	44
6	Take pictures of the moon	42

to do the tasks properly and interestingly. The aim of these videos is lead the learners to be the authorities on subjects by investigation, storytelling, and production (Johnson, Adams Becker, Estrada, & Freeman, 2015).

As shown in Table 3, the numbers of the last column (CTR) represent the total times per teaching-video had been viewed. According to the results, the most popular video is making moon cakes, which empowers learners to be moon-cake cookers in real life. Other videos are also welcomed, such as poesy recitation, making Lord Rabbit and making phase diagram. The viewed times of making e-greeting card and taking pictures of the moon are relatively lower.

4.2. Relationships between mobile learning behaviors and personal characteristics

4.2.1. Gender and grade difference

T-test analysis (Table 4) shows that boys played longer time and submitted more digital products than girls, while the girls had higher login frequencies and a slight higher correct rate of answering questions than boys, but the gender differences in mobile learning behaviors failed to reach statistical significance. These results indicate that students in both genders report similar mobile learning behaviors in the current study.

Meanwhile, we conducted ANOVA analysis to test the grade difference in the mobile learning behaviors. Table 5 shows that grade has statistically evident impacts on students' correct answer rate ($p = 0.043$), while no significant differences in other variables of mobile learning behaviors. As shown in Table 5, the higher grade the students are in, the better correct answer rate they had achieved.

4.2.2. Learning styles differences

We classified the learning styles based on students' scores on the active–reflective, sensory–intuitive, visual–verbal and sequential–global styles. The results indicated that 71% participants are active in information processing while 29% are reflective; 53% are classified as sensory in information perceiving while 47% are intuitive; 78% participants are visual style in the information presenting while 22% are verbal; 75% are sequential in informational understanding while the rest of the 25% are global. The results show that the most of the students are active, visual and sequential in the learning style.

To learn the detail about differences on learning style in mobile learning environment, we classified four dimensions with value from 1 to 11. Subscores on the ILS were classifies as "low" if the

Table 4. Gender differences in mobile learning behaviors.

$N = 83$	Boys M (SD)	Girls M (SD)	t	p
Frequency of login	6.89(6.61)	6.92(4.56)	−0.029	0.977
Learning time duration	41.88(37.20)	37.20(23.50)	1.714	0.091
Correct answer rate	0.71(0.15)	0.72(0.17)	−0.290	0.773
Number of products submitted	2.00(3.23)	1.62(3.01)	0.809	0.424

*$p < 0.05$.

Table 5. Grade difference in mobile learning behaviors.

	G3 M (SD)	G5 M (SD)	G6 M (SD)	F	p
Frequency of login	6.50(9.63)	7.41(4.66)	6.19(2.56)	0.377	0.687
Learning time duration	24.97(13.32)	41.37(34.91)	35.95(34.91)	1.727	0.184
Correct answer rate	0.65(0.11)	0.71(0.15)	0.77(0.19)	3.27	0.043*
Number of products submitted	4.21(3.12)	3.88(3.35)	3.13(2.90)	0.300	0.743

*$p < 0.05$.
G3 = the 3rd grade, G5 = the 5th grade 5, G6 = the 6th grade.

values were between −1 and −3 or between 1 and 3; "average" if they were between −7 and −5 or between 5 and 7; or "high" if they were between −9 and −11 or between 9 and 11.

Box plots were generated to assess the central tendencies and dispersion for each dimension among all participants (Figure 7). The box plot shows the median (central line within the box), the first quartile (lower edge of the box) and the third quartile (upper edge of the box), as well as outliers (dots) with values more than 1.5 times the value of the interquartile range (distance between the lower and upper edges of the box).

The dimensions of active–reflective and visual–verbal show significant asymmetry in that the median in the dimension of active–reflective is equal to 1. Therefore, 50% of the participants performed active–reflective more than 1. A group corresponding to 25% in all participants dedicated more than 5 and another group of 25% made an effort below -1. The middle bar in the dimension of visual–verbal shows that the median is equal to 3, which indicates that 50% of the participants performed active–reflective more than 3. A group corresponding to 25% of all participants dedicated more than 7 and another group of 25% made an effort below 1. These findings suggest that students' learning styles are more likely active and visual in mobile learning environment.

We conducted Pearson correlation analysis to determine whether the learning styles were associated with various mobile learning behaviors. The results of Table 6 indicate that active–reflective learning style shows significant association with correct answer rate ($r = 0.226$; $p = 0.04$; $r = -0.223$; $p = 0.042$). The active learning style has a positive impact on students' correct answer rate. On the contrary, the reflective learning style shows passive impact. These findings suggest that active learners achieved higher correct answer rate. They had better performance in answering questions about the culture by mobile self-learning in the BC-Book.

4.2.3. Correlations with conventional test scores

To confirm the relationships between the test scores in conventional courses (Math, Chinese and English) and mobile learning behaviors, we performed Pearson correlation analysis involving twelve scalar variables, as shown in Table 7. The results indicate that the score of the Chinese courses had significant correlation with the correct answer rate in the BC-Book.

5. Discussion and conclusion

The purpose of this study is to detect the features of mobile learning behaviors among elementary students in China, and the relationships between the personal characteristics and mobile learning behaviors. Some noteworthy findings are summarized as below.

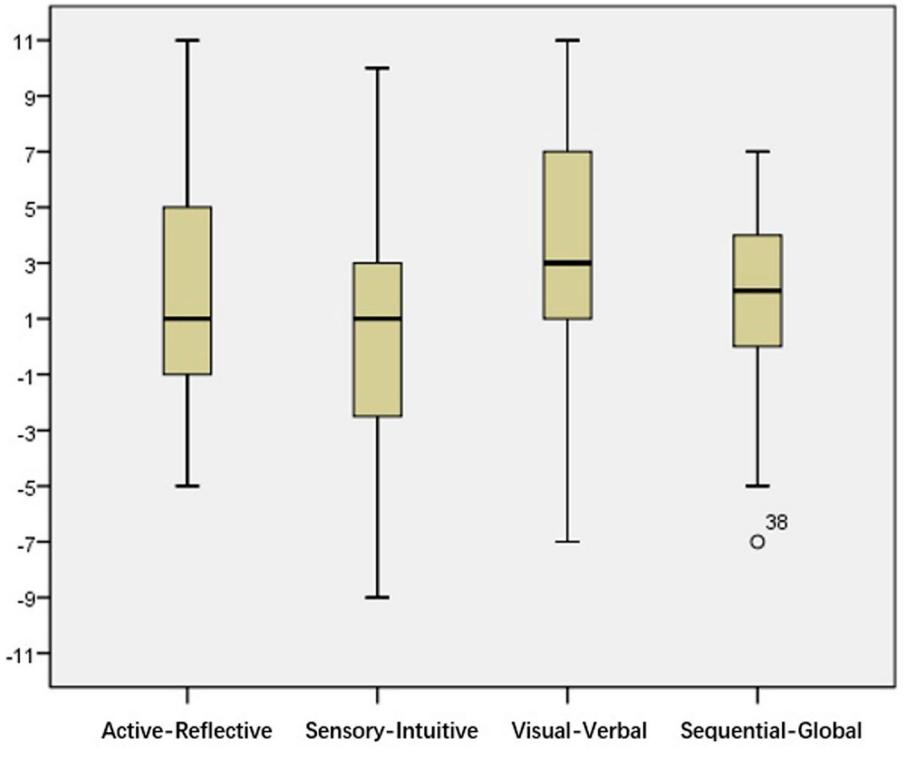

Figure 7. The box plots of learning styles.

5.1. Features of mobile learning behaviors

The average learning duration is 36 min per login time and 6.8 login times in the four weeks. This finding and the result of Table 1 indicated that students enjoyed mobile learning via BC-Book, and showed good self-regulated mobile learning ability in school. This result was not only consistent with prior literature that game-based mobile learning is promising in improving students' learning motivations and interests (Hwang & Wu, 2014; Su & Cheng, 2015), but also proved another assumption that effective mobile learning is depended on learners' capabilities in rightfully determining what, when, and how to learn, as well their willingness to behaviorally and cognitively engage in learning whenever or whatever they themselves realize it is needed (Sha, Looi, Chen, & Zhang, 2012).

Without face-to-face lecture from the teachers, young students got 70% correct rate in answering questions about tradition culture in the game module of BC-Book by mobile self-regulated learning. The result echoes many previous studies about the effectiveness of mobile learning in promoting the

Table 6. Correlations between learning styles and learning behaviors.

	Frequency of login	Learning time duration	Correct answer rate	Number of products submitted
Active	0.058	0.036	0.226*($p = 0.04$)	0.063
Reflective	−0.045	−0.037	−0.223*($p = 0.042$)	−0.06
Sensory	0.035	−0.146	−0.097	0.179
Intuitive	−0.027	0.151	.0101	−0.145
Visual	−0.052	0.156	0.099	−0.070
Verbal	0.057	−0.151	−0.094	0.070
Sequential	0.017	−0.16	0.021	−0.010
Global	−0.025	0.189	−0.009	0.029

*$p < .05$.

Table 7. Correlations between conventional test scores and mobile learning behaviors.

	Math	Chinese	English
Frequency of login	0.129	0.176	0.105
Learning time duration	0.183	−0.104	−0.202
Correct answer rate	−0.031	0.046*	−0.001
Number of products submitted	−0.071	−0.068	−0.027

*$p \leq 0.05$.

learning performance for the elementary students. (Boticki, Baksa, Seow, & Looi, 2015; Hwang & Wu, 2014; Liu & Chu, 2010; Shih, Chuang, & Hwang, 2010). Compared with the conventional teacher-central lecture teaching, student-centered mobile learning involves more than technological or pedagogical considerations, learners' mobile learning features such as login duration, frequencies, self-regulated learning abilities in controlling one's learning in mobile settings need also to be considered. With appropriate supervision, teachers and parents should trust in the elementary students and provide more mobile learning opportunities in school.

Moreover, the data in the Table 2 showed that positive significant correlations among various mobile learning behaviors. Students, whom had the higher login frequencies and learning duration, scored higher correct rate in answering academic questions about the Chinese traditional culture, and submitted more digital products in the BC-Book.

However, it is regrettably that the participants in the study showed more digital consuming than digital creating according to the result of Tables 1 and 3. Students spend over 3000 min and average 36.4 (SD = 32.3) minutes per person in mobile learning. They watched six teaching videos for 286 times in sum and average 3.45 videos per student, but only 39 out of the 83 students submitted digital products with 1.81(SD = 3.13) on average. The observed results find evidence to support the claims regarding students who had the feature of the digital natives. The students who were born in twenty-first century variably named Millenials, Net Generation, and Digital Natives (Howe & Strauss, 2000; Prensky, 2001; Tapscott, 1998). However, many digital natives prefer a moderate amount of technology in their courses, and use technology primarily for convenience, connection but creating (Caruso & Kvavik, 2005; Margaryan, Littlejohn, & Vojt, 2011).

5.2. The relationships between personal characteristics and mobile learning behaviors

Students in the current study showed different advantages in various aspects of mobile learning behaviors, but no significant difference was founded in genders according to Table 4. The current result is in accordance with some research. Huang, Liang, Su, & Chen, (2012) designed a personalized e-book, tracked reading rate to reflect students' learning behaviors and found no gender difference. Wanless et al. (2013) investigated individual and classroom behavioral regulation in four societies: the United States, Taiwan, South Korea, and China. Results showed that girls in the United States had significantly higher individual behavioral regulation than boys, but there were no significant gender differences in any Asian societies. Although gender difference was found in a Korea's research that mobile phone overuse was greater in girls than in boys in elementary schools, and the difference was statistically significant (Kim, Lee, & Choi, 2015), but the possible reason is the difference of the experiment environments. The former several research were to learn academic contents in formal learning setting with teachers in side, while the latter one was to entertainment in the afterschool setting with full usage autonomy. Actually, mobile phone addiction among adolescents had close bidirectional relationships with depressive symptom (Jun, 2016).

In addition, grade difference exits in the present study according to the result of Table 5 that the higher-grade students achieved significantly higher correct rate on answering questions. The finding coincides with the study of Hsieh et al. (2016) who prospered that students of higher grade had significantly higher scores in both performance and flow experience than the students of lower grade. The possible reason for gender difference could be the lower grade elementary students still need

more guidance and techniques from the teachers and supervisors than higher graders to achieve accurate academic knowledge understanding and application (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). These findings leading us to conclude that mobile learning in school setting is suitable for both genders, and suggest that teachers and course designers pay more attention on the grade difference to construct mobile academic courses for the elementary students.

As showed in Table 6, students with active informational processing style achieved prominent advantage in answering rate of learning content than with reflective processing style. Other three dimensions performed somewhat advantages on mobile learning behaviors, but failed to reach statistical significance. In line with prior literature, students with some specific leaning style showed better learning performance in the tech-based learning environment. Sun et al. (2008) explored the learning effect related to different learning styles in a web-based virtual science laboratory for elementary students. The results concluded that students with accommodator learning styles were significantly different from other on test score. Bolliger & Supanakorn (2011) examined the effects of learning styles on learner perceptions of using interactive tutorials and found significant main effect on learning style. Hence, learners with specific learning style had the potential weakness in low achievement. How to integrate the nature of learning style with mobile learning environment deserved more attention to benefit low achievers' performance (Chen, 2015).

5.3. Test scores of conventional Chinese subject had close correlation with correct rate of answering questions in mobile learning

Not surprisingly, there was a positive relationship between the test score of Chinese subject in the conventional courses with the correct rate of answering questions about Chinese culture in mobile learning course according to the results of Table 7. However, scores of other conventional subjects, Math and English, had no similar close correlations. A possible reason is that main knowledge in the mobile course focuses on the conventional Chinese culture. Students had learning experience in Chinese subject about other tradition cultures. It is easy for students to transfer the learning method and information process between the Chinese subject and the current mobile course. The significant correlation could help teachers and parents to predict and help lower achievers in Chinese conventional courses to get better preparation in mobile learning about academic social science courses in school. This finding deserved further investigation for applying in other academic courses like science or EFL.

6. Limitations and implications

In this study, we investigated the features of mobile learning behaviors among Chinese elementary students, and the relationships between the mobile learning behaviors and personal characteristics. The major findings are 1) students had reasonable login frequencies and learning time duration with appropriate guidance from teachers, and satisfying learning performance by self-learning in mobile environment, 2) higher grade, learning style with active information processing and the test scores in the conventional Chinese subject course had positive impacts on mobile learning behaviors but no gender difference was founded. Regrettably, the result showed that students had more digital consuming than digital creating in the current study.

These findings are helpful to improve the design mobile learning courses for the elementary students. The implications of this study are as follows: 1) the elementary students had satisfactory self-regulated control ability for gamed-based mobile learning in school with teachers' guidaance, and teachers should consider create more opportunities for them to learn in interactive learning environment; 2) the design and application of mobile learning course for traditional cultures are effective and worth replicating in other social science courses; 3) students' grade, learning style and test scores of the tradition courses should be taken into consideration when design mobile learning environment for elementary school level course.

The major limitation in this study were the small size sample from one country, short term experiment and absence of control groups. More research should be conducted with larger samples with an equivalent group experiment, and future research should point to the cross subject or cross-culture to result in different mobile learning behavior patterns.

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