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The Effect of Integrating Learning Style with Mobile Cooperative Learning on Learning Achievement and Attitude

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In a learning environment that integrates technology with cooperative learning, interaction is believed to be essential to improving learning. However, traditional desktop computers are not suitable for face-to-face interaction while mobile tools enable students to interact naturally. Moreover, computer-mediated communication may not totally benefit low achievers' performance and interaction. The heavy cognitive load from mobile learning deteriorates performance and learning style may affect cognitive load. More assistance to individual students becomes indispensable. This study developed a learning style, integrated with mobile cooperative learning environment system (LSIMCL). The results showed that the LSIMCL group performed better than the non-LSIMCL group. The low achievers outperformed the medium and high achievers in their learning increase. Moreover, the LSIMCL students had more score growth and perceived the environment to be more adaptable, interactive, and satisfying than the non-LSIMCL group. In the non-LSIMCL group, the low achievers had more difficulty, needed more effort and attention when reading the e-book than the other achievers, while there was no difference for the LSIMCL group. The findings would be valuable for instructors who intend to develop a mobile cooperative learning environment while taking individual learning differences into consideration.

Keywords: mobile cooperative learning, learning style, jigsaw

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Introduction

In an educational environment that integrates modern technology, a method of guiding learners toward effective interaction becomes indispensable (Alavi & Gallupe, 2003; Bannan-Ritland, 2002; Resta & Laferrière, 2007). Cooperative learning has usually been used to improve interaction (Jacob, 1999; Slavin, 1999). Many studies show that cooperative learning has a positive influence on students' learning outcomes. Further, cooperative learning has often been used for every age (Bruffee, 1995; Kyndt et al., 2013), learning level (Shimazoe & Aldrich, 2010), and field (Barker, Quennerstedt, & Annerstedt, 2013; Jacobs & Kimura, 2013; Leng, Leng, & Abedalaziz, 2013; Nunnery, Chappell, & Arnold, 2013; Topping, Thurston, Christie, Murray, & Karagiannidou, 2011), as well as for activities ranging from basic skill learning (Shoval & Shulruf, 2011) to complex problem solving (Gillies & Haynes, 2011). Most of the studies that integrate cooperative learning and Internet-based learning claim that cooperative learning has a positive influence on academic performance. Moreover, computer-mediated cooperative learning is indispensable in aiding teaching and face-to-face interactions (Alavi, 1994; Alavi, Wheeler, & Valacich, 1995; Lou, Abrami, & d'Apollonia, 2001; Sun & Lin, 2007). The process of computer-mediated cooperative learning emphasizes learners' interdependence and cooperation. Group members should have perfect interaction to achieve positive learning outcomes. Positive interaction leads to students' active learning because it helps them reach their learning goals and perfects their learning performance (Osman & Herring, 2007; Saleh, Lazonder, & de Jong, 2007).

Currently, most computer-mediated cooperative learning requires students to sit in front of desktop computers and communicate through their use. However, traditional desktop computers are not suitable for face-to-face interaction, which is essential in an effective cooperative learning environment. Using mobile tools such as tablet PCs and mobile phones can create a mobile cooperative learning environment that enables students to interact face-to-face naturally (Tartar, Roschelle, Vahey, & Penuel, 2003). Zurita and Nussbaum (2004) also pointed out that mobile cooperative learning not only enables learning groups to interact face-to-face, but eliminates the restriction of space, as information from the Internet can also be utilized. In the computer-mediated cooperative learning environment, one of the most commonly used strategies in cooperative learning is Jigsaw (Huang, Huang, & Hsieh, 2008; Lai & Wu, 2006; Tsiatsos, Andreas, & Pomportsis, 2010).

There are five steps in this strategy (Aronson, Blaney, Stephin, Sikes, & Snapp, 1978; Aronson & Patnoe, 1997; Huang et al., 2008; Lai & Wu, 2006).

Moreover, although computer-mediated communication can promote learners' learning performance and develop their ability to solve complex problems, some researchers have asserted that it may not benefit all kinds of learners. Students with low ability may remain at their low performance levels (Gambari, Kutigi, & Fagbemi, 2014) and fell substantially short in interaction especially social construction of knowledge (Heo, Lim, & Kim, 2010) and contribution (Serce, Swigger, Alpaslan, Brazile, Dafoulas, & Lopez, 2012). Students should be provided with appropriate and prompt assistance according to their needs to improve learning (Gambari et al., 2014; Lan, Sung, & Chang, 2009). Furthermore, mobile learning brings negative effects in heavy cognitive load if learning is not designed properly (Chu, 2014; Hwang, Wu, Zhuang, & Huang, 2013; Liu, Lin, Tsai, & Paas, 2012) and learning style may have an effect on cognitive load (Abdul-Rahman & du Boulay, 2014). Felder and Silverman (1988) recognize students' individual differences. In the learning process, every student has his or her own learning preferences. Instructors should consider learners' learning style when designing learning materials (Graf, Liu, Kinshuk, Chen, & Yang; 2009; Sandman, 2009).

Overall, cooperative learning is important to improve interaction in technology-integrated education and applying mobile tools could improve face-to-face interaction. Moreover, computer-mediated communication does not totally benefit students with low ability in their performance and interaction. The heavy cognitive load brought from mobile learning deteriorates performance and learning style may affect cognitive load. It has become essential to consider different learning styles when designing instruction and there is limited empirical research that has investigated learning performance, satisfaction as well as cognitive load in the learning style integrated mobile cooperative learning (LSIMCL) environment. This study developed a mobile cooperative learning environment that integrates different learning styles and tries to compare students' academic performance between the groups with and without integrated learning styles as well as different (low, medium, and high) achievement levels and learning styles. The learning growth was also compared to look into more detail investigating which level, group, or learning style was improved most. Students' attitude towards adaptivity, interaction, learning satisfaction and cognitive load (difficulty, effort, and attention)

was examined to find out how the proposed model benefited which group, level, especially the low achievers and learning style. Finally, students' experience was collected from qualitative data to explore recommendations to the LSIMCL environment.

Background

Mobile Cooperative Learning

According to Keegan (2002, p. 6), mobile cooperative learning is to combine cooperative learning and mobility. The instructors could imply cooperative learning strategies and use mobile devices to interact with peers and instructors. Zurita and Nussbaum (2004) combined cooperative learning and mobile learning and called it mobile computers assisted cooperative learning or mobile cooperative learning. They further pointed out that learning in a mobile cooperative learning environment improves mobility, group-work, and interaction. Roschelle and Pea (2002) brought out four advantages in mobile cooperative learning such as broaden the learning space in real classes, summarize all students' individual contribution, improve class performance, and learning through discussion as well as interaction with others. Integrating mobile devices into cooperative learning enables students to exchange knowledge face-to-face and provides learners more chances to think independently (Danesh et al., 2001; Imielinsky & Badrinath, 1994). The Jigsaw strategy was used in the cooperative learning environment because it is widely used and improves students' learning effects (Huang et al., 2008; Lai & Wu, 2006). It is proved suitable for different level of students and usually includes five steps in the learning process (Aronson et al., 1978; Aronson & Patnoe, 1997; Huang et al., 2008; Lai & Wu, 2006):

(a) Topic assignment: The instructor first introduces the course content and assigns students to different groups so each student will learn different contents from his or her group members.

(b) Individual study: Learners are asked to read the assigned content individually. They need to understand it thoroughly to prepare for the discussions afterwards.

(c) Expert group meeting: The students who are assigned the same topic meet to share and discuss what they have learned. This step facilitates the familiarity of the topic for the Jigsaw group discussions afterwards.

(d) Jigsaw group meeting: Each "expert" comes back to the assigned group and shares what he or she has just learned. The other group members are encouraged to ask questions to help their understanding.

(e) Class presentation: To give each group an opportunity to demonstrate and share what they have learned, instructors provide advice and ask questions to provoke deeper discussions and critical thinking.

Lai and Wu (2006) applied the Jigsaw strategy in a hand-held computer supported cooperative learning environment in a medical course. The students used PDA to download learning materials and presented outcomes. The results showed the experimental group had higher satisfaction and performance. However, the PDAs were not able to directly connect to projectors and became inconvenient in class activities. The various operating systems increased the difficulty of using related softwares and blue-tooth led to miss transmission of files. The research used iPad with wireless internet so the experiment was not influenced by different operating systems and blue-tooth miss transmissions. The iPads could also easily connect to projectors for knowledge sharing and discussions.

Learning Styles

Felder and Silverman (1988) recognize students' individual differences. In the learning process, every student has his or her own learning preferences. In most instances, learning difficulties occur when students' learning style does not match the teacher's teaching style (Felder & Silverman, 1988; Hsieh, Jang, Hwang, & Chen, 2011). Teaching is the interactive process between teachers and students. If a teacher wants to teach successfully, he/she should not only have appropriate teaching skills but also consider students' individual differences. Students will obtain knowledge only when they are taught according to the most appropriate method (Çakıroğlu, 2014). Therefore, when designing learning materials, instructors should consider learners' learning style to improve students' attitudes towards adaptivity of learning (Graf, Liu, & Kinshuk, 2010; Kinshuk, Liu, & Graf, 2009) and interaction (Brown et al., 2009). Brown et al. (2009) conducted a study to

determine whether learning style preferences predicts their attitudes to learning including student interaction and advised that educators should consider learning style in the context of using technology for education. Graf et al. (2010) stated that students with different learning styles use different strategies to learn and navigate through the course. The findings provided information for learning management systems designers to extend their adaptive functionality. Kinshuk et al. (2009) investigated that students with strong learning preferences got lower scores in an object-oriented modeling course and emphasized the importance of adaptivity of learning environment. Adopting learning styles improves students' learning (Çakıroğlu, 2014; Chen & Chiou, 2014; Franzoni & Assar, 2009; Yang, Hwang, Yang, 2013). Franzoni and Assar (2009) described the design of an adaptive teaching method combined with the selection of appropriate teaching strategy and electronic media based on learning styles to help students efficiently improved their learning process. Yang et al. (2013) proposed a personalized presentation module based on learning style and cognitive style in a computer science course in higher education. The results showed the students had improvement in their learning performance. The cognitive load could be lowered in an adaptive learning environment (Abdul-Rahman & du Boulay, 2014) by matching teaching contents (Franzoni & Assar, 2009). Abdul-Rahman and du Boulay (2014) tried to demonstrate how learning styles have an effect on learners' cognitive load. The results showed that the active and reflective learning styles may have interacted with cognitive load and thus affect learning outcomes.

Felder and Silverman (1988) classified students' learning styles into active/reflective, sensing/intuitive, visual/verbal, and sequential/global, as described below:

1. Active/reflective: Active learners tend to acquire information by active doing, while reflective learners prefer to think first.
2. Sensing/intuitive: Sensing learners tend to memorize facts and like to connect to the real world, while intuitive learners are more comfortable with abstract concepts and prefer to find out relationships.
3. Visual/verbal: Visual learners tend to learn from visual objects such as pictures, films, charts, and diagrams, while verbal learners learn most from words and audial explanations.
4. Global/sequential: Global learners usually try to grasp the big picture first,

while sequential learners prefer to understand in linear steps.

In this study, since the content of nutrition education at the primary school level consists of many concrete ideas rather than abstract concepts, two of Felder and Silverman's (1988) learning styles related to designing self-studied materials, visual/verbal and sequential/global, were used to design adaptive ebooks. The ebooks were used in the "individual study" step of the Jigsaw model in the mobile cooperative learning environment.

The purpose of the study was to understand whether a learning style integrated mobile cooperative learning system improves primary school students' level of academic performance and whether this system results in higher learning satisfaction for students with different achievement levels and learning styles. The four research questions are listed below:

1. In the mobile cooperative learning environment, is there any difference in learning outcomes between students who use or do not use the learning style integrated mobile cooperative learning system (LSIMCL) in different achievement levels and learning styles?

2. In the mobile cooperative learning environment, is there any difference in learning growth between students who use or do not use the learning style integrated mobile cooperative learning system (LSIMCL) in different achievement levels and learning styles?

3. In the mobile cooperative learning environment, is there any difference in learning attitude (adaptivity, interaction, satisfaction, learning difficulty, effort, and attention) between students who use or do not use the learning style integrated mobile cooperative learning system (LSIMCL) in different achievement levels and learning styles?

4. What is students' experience using the learning style integrated mobile cooperative learning system (LSIMCL)?

Methodology

Participants

This was a quasi-experimental research study of four intact classes and 124 sixth-grade students participated in the experiment. The research was conducted at a primary school in Taiwan. In order to assess whether adaptive cooperative mobile learning improves participants' performance and satisfaction in learning health, four nutrition topics were chosen, and the course materials were designed as mobile eBooks. Almost 51.43% of the participants were male, and 48.57% were female. All students in the research were required to read the course materials and participate in the Jigsaw activities. The course materials were highly related to the course content to help the participants understand and review what they had learned in class. Two classes with 61 students were randomly assigned as the LSIMCL group, which used ebooks integrating learning styles and Jigsaw strategy in the class. The other two classes including 63 students were named the non-LSIMCL group, and the course was taught with Jigsaw activities and ebooks mismatch students' individual learning styles.

The students' achievement levels were based on their Health Education grades in the previous semester. Those scored in the first 33% in the class were called high achievers and those in the last 33% in the class were low achievers. All the rest in the middle 33% were medium achievers. In the LSIMCL group, there were 20 high achievers, 20 medium achievers, and 21 low achievers while there were 19 high achievers, 24 medium achievers, and 20 low achievers in the non-LSIMCL group. The students' academic performance and attitude toward their learning environments were compared and discussed. After taking the Index of Learning Style questionnaire, In the LSIMCL/non-LSIMCL group, there were 16/14 verbal-sequential, 15/12 verbal-global, 13/18 visual-sequential, and 17/19 visual-global students.

Ebook Design

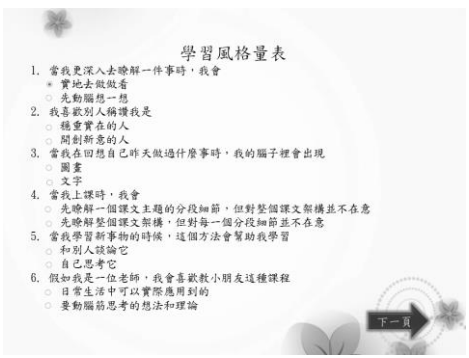
When opening up the ebooks, the Learning Style Questionnaire adapted from Soloman and Felder (1993) would appear to find out students' learning styles (see Graph 1). The system then directed the students to read the content according to their learning styles. There were four types of ebooks for each topic. The four types included visual-global, visual-sequential, verbal-global, and verbal-sequential based on the visual/verbal and sequential/global dimensions from Felder and Silverman (1988).

(a) The visual-global version explained concepts with mainly pictures and video clips, and in a global pattern (see Graph 2). The students could go back to the main menu and were free to jump to any topic that interested them.

(b) The visual-sequential version provided students with mainly multimedia resources such as graphs and video clips, and the entire content was presented in a linear format by clicking the previous page and next page buttons (see Graph 2). The main menu page was not available in this version.

(c) The verbal-global version provided content mainly using texts in a global pattern. The students could use the menu button to reach the main menu page and go to any topic of their interest by clicking on the main menu (see Graph 3).

(d) The verbal-sequential version focused on using texts to present course content in a linear presentation (see Graph 3). Students could only navigate the ebook by clicking the next page and previous page buttons. The main menu page was not accessible to them.

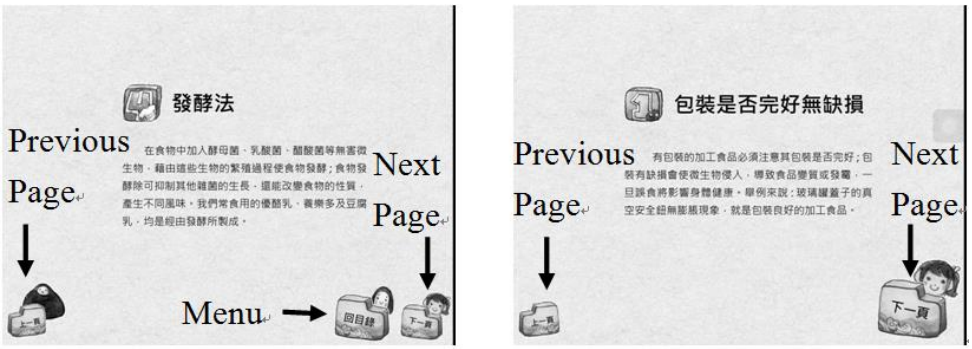


Graph 1.

Students were directed to take the Learning Style Questionnaire in the ebook to investigate their learning styles.

Graph 2.

After taking the Learning Style Questionnaire, students' ebooks based on their learning style were shown on the screen. In the visual-global version (left) of the ebook, the students could freely choose their reading sequence by clicking on "Menu" button and the content was mainly explained in pictures and video clips while the visual-sequential version (right) provides students to navigate linearly.



Graph 3.

In the verbal-global version of the ebook (left), the students could go to the menu page and the content was mainly explained in texts while In the verbal-sequential version (right), the students could only go to the next or previous page and the content was also mainly explained in texts.

Procedure

Both LSIMCL and non-LSIMCL groups were taught the same content by the same instructor. Moreover, both groups followed the Jigsaw strategy in class. The procedure is described below:

(a) Topic assignment: After introducing how to use ebooks and the learning process, each student was given an iPad to take the Learning Style Questionnaire adapted from Soloman and Felder (1993). The questionnaire data were then analyzed by the system, and each student's learning style was shown on the screen. After identifying the learning styles of all the students in the class, each student were assigned to a Jigsaw group. The system tried to assign as many different kinds of learning styles as possible (visual-global, visual-sequential, verbal-global, verbal-sequential), and four to five students were assigned to each group.

(b) Individual study: The system provided an ebook according to the student's learning style. Each student read the content individually. The ebook was designed according to the visual/verbal and sequential/global dimensions from Felder and Silverman (1988) and described in the ebook design section.

(c) Expert group meeting: The students with the same assigned topic met with their iPads and tried to answer the questions on the worksheet by discussing them with other "experts".

(d) Jigsaw group meeting: Each expert returned to his or her original jigsaw group and shared what he or she had learned with the other group members. The students had to try their best to help their peers comprehend important concepts because the average post-test scores of the whole group affected each student's final score.

(e) Class presentation: Each group shared what they had written on the worksheet. The instructor gave advice, asked questions for higher level thinking, and praised the group with great performance.

The entire treatment lasted four weeks. The participants were required to take a pre-test before the treatment to investigate their prior knowledge. After the treatment, a comprehensive post-test and the Ebook Use Questionnaire were used to evaluate whether there was a significant difference in learning outcomes or learning satisfaction between the two groups.

Measurement

Prior to the treatment, Index of Learning Styles (ILS) questionnaire (Soloman & Felder, 1993) was administered to the participants to determine their preferred learning style. The entire questionnaire included 44 questions. The experiment was particularly concerned with the visual/verbal and sequential/global dimensions of the ILS so 22 questions were used in this study. The value of cronbach α of the ILS questionnaire was 0.89. Each pre-test and post-test included 25 questions. The questions were different but had similar levels of difficulty. The value of cronbach α of the pre-test and post-test were 0.82 and 0.86 respectively. The Pearson's *r* was 0.78, which showed high correlation between the pre-test and post-test. The average

item difficulty index of the pre-test and post-test were 0.47 and 0.45 respectively. The average item discrimination index of the pre-test and post-test were 0.83 and 0.87 respectively. The tests were developed by the instructor and reviewed by content experts.

The Ebook Use Questionnaire was used to investigate students' attitude toward learning environments and included 22 questions. The first 17 questions were adapted from Cochrane (2010) and So, Tan, and Tay (2012). Respondent ratings of the students' perceptions of the adaptability of the learning materials, interaction, and learning satisfaction obtained from the questionnaire were all judged to be fairly reliable with internal consistency reliability coefficients of 0.97, 0.94, and 0.96, respectively. The adaptability refers to the extent to which the ebooks were adaptable according to their learning needs such as "I think the ebook suited my navigation habits." The interaction section refers to the extent to which the students communicate and social construct their knowledge in the class such as "I have shared my knowledge and information with others in the class." The satisfaction section refers to how the students were satisfied with their class such as "Based on my experience in this class, I would like my other classes to be the same. We used CFA to verify the factorial validity and stability of the first three constructs. For the CFA model, the difference of X^2/df ratio value was 2.984 and was close to an acceptable ratio (Kline, 2005). The RMSEA was 0.076 and the SRMR was 0.068, both below 0.08 (Brown, 2006; Hooper, Coughlan, & Mullen, 2008). The CFI was 0.982, the GFI was 0.957, and the NNFI was 0.968, all beyond 0.9, generally indicating good model fit (Schumacker & Lomax, 1996; Tabachnick & Fidell, 2001). Each item had a substantial loading between 0.691 and 0.874 on the three factors, and each loading was statistically significant. The composite reliability of each construct were 0.840, 0.813, and 0.876, all were above 0.6 (Bagozzi & Yi, 1988). The Average variance extracted (AVE) were 0.631, 0.673, and 0.649, all were beyond 0.5 (Fornell & Larcker, 1981).

Question 18-20 was related to students' cognitive load adapted from Sweller, Van Merrienboer and Paas (1998) on a 9-point Likert scale. The questions included the extent to which the difficulty of reading the ebook, the effort they need when reading the ebook, and how much attention they need when reading the ebook. The questions were used to examine the extent to which the cognitive load students have in the class. It is judged to be fairly reliable with internal consistency reliability coefficients of 0.88, 0.82, and 0.85. The last two questions were open-ended

questions to investigate students' perception of the benefit, drawback and recommendation after the treatment. The questions included "Do you think which portion of the class benefits you?" and "Is there any drawback or recommendations you have after this class?"

Data Collection and Analysis

To answer research question one, the data collected from the pre-test and post-test was used to investigate if there was difference in learning performance between students in the LSIMCL and non-LSIMCL groups in different achievement (low, medium, and high) levels and learning styles. The data was then analyzed using two-way ANCOVA to examine the effect of LSIMCL on achievement after controlling the pre-test score. To explore that LSIMCL and non-LSIMCL benefited which achievement level and learning style most, the score difference from the pre-test and post-test was then used to answer research question two. The scores were analyzed by two-way ANOVA. To investigate how LSIMCL helped learner with different achievement levels and learning styles, data collected from the Ebook Use Questionnaire was used and analyzed by two-way ANOVA to understand students' attitude towards adaptivity, interaction, and learning satisfaction as well as their cognitive load including the level of difficulty, effort, and attention needed in the class and when reading the ebooks. Besides quantitative data, qualitative data from two open-ended questions in the Ebook Use Questionnaire and face-to-face interviews were collected to find out students' experience in LSIMCL to provide recommendations. Three trained graduate students as researchers examined the answers to the open-ended questions as well as the interviews were transcribed and analyzed. Qualitative data analytical method was used to interpret and summarize the themes from the qualitative data. To attain the high inter-rater agreement, they discussed the transcriptions, rechecking coding and seeking for higher agreement (94%) on the data analysis.

Results

LSIMCL, Achievement Levels, Learning Style, and Academic Performance

A two-way analysis of covariance (ANCOVA) was employed to investigate the pre-test and post-test scores to answer Research Question 1. In assessing the homogeneity of regression, the results of the F-test of the product terms for each group and the pre-test scores did not violate the regression's assumption of homogeneity (F= 2.92, p = .13 > .05). Therefore, there was no interaction effect, and we can assess the effects of LSIMCL on achievement after controlling the pre-test score. There was a statistically significant interaction effect between treatment group and achievement levels ($F_{1, 118}$ = 118.13, p < .001). The tests of simple main effects showed that for low achievers ($F_{1,38}$=33.88, p<.001), medium achievers ($F_{1,43}$=49.51, p<.001) and high achievers ($F_{1,40}$=44.28, p<.001), the LSIMCL group had significant higher performance than those in the non- LSIMCL group. In the non-LSIMCL group, the low achievers had significant lower scores than medium and high achievers did ($F_{2,62}$=27.85, p<.001), while there was no significant difference between achievement levels ($F_{2,60}$=5.91, p=.06) in the LSIMCL group. The results are in Table 1.

Table 1.

Pretest, Post-test Scores, and Score Growth

Groups	Pre-test		Post-test		Score growth		N
	Mean	*s*	Mean	*s*	Mean	*s*	
LSIMCL							
Low	41.72	6.42	80.60	9.24	38.88	8.77	20
Medium	57.62	3.08	83.50	9.80	25.88	10.98	20
High	67.24	3.52	89.76	7.03	22.52	5.60	21
total	55.72	11.54	84.70	9.43	28.98	11.11	61
Non-LSIMCL							
Low	43.68	4.36	60.06	12.63	16.37	14.26	19
Medium	57.50	2.24	68.07	4.06	10.57	4.18	24
High	67.84	3.44	78.18	3.42	10.34	1.64	20
total	56.62	10.16	68.86	10.39	12.25	8.59	63
Total							
Low	42.68	5.53	70.59	15.05	27.91	16.27	39
Medium	57.55	2.62	75.08	10.57	17.53	11.05	44
High	67.53	3.45	84.11	8.04	16.58	7.41	41
total	56.17	10.82	76.66	12.69	20.48	12.96	124

The data was further analyzed using two-way ANCOVA to examine if there was difference between learning styles and treatment group. In assessing the homogeneity of regression, the results of the F-test of the product terms did not violate the regression's assumption of homogeneity (F= 19.79, p = .17). There was no interaction effect so we can assess the effects of LSIMCL. A statistically significant difference existed between treatment groups ($F_{1, 115}$ = 110.03, p < .001) and the LSIMCL group (M=84.70, s=9.43) was higher than non-LSIMCL group (M=68.86, s=10.39). There was no statistically significant difference between learning styles ($F_{3, 115}$ = .16, p = .92) nor interaction effect between treatment group and learning styles ($F_{3, 115}$ = .20, p = .89).

LSIMCL, Achievement Levels, Learning Styles and Academic Growth

To answer Research Question 2, a two-way ANOVA was also employed to look at the difference between pretest and posttest scores. There was a statistically significant interaction effect between treatment group and achievement levels ($F_{1,118}$=3.88, p=.02, η^2=.06). The results are shown in Table 1. Tests of simple main effects were performed on the difference between pretest and posttest scores according to achievement levels and treatment groups because the interaction effect is significant. For low achievers, there was a significant difference between LSIMCL and non-LSIMCL groups ($F_{1,37}$=35.67, p<.001). The low achievers in the LSIMCL group (M=38.88, s=8.77) had higher gain from the pretest than those in the non-LSIMCL group (M=16.37, s=14.26). There was also a significant difference between treatment groups for the medium achievers ($F_{1,42}$=39.91, p<.001). The medium achievers in the LSIMCL group (M=25.88, s=10.98) also had higher increase than those in the non-LSIMCL group (M=10.57, s=4.18). Moreover, here was a significant difference between treatment groups for the high achievers ($F_{1,39}$=87.31, p<.001). The high achievers in the LSIMCL group (M=22.52, s=5.60) also had higher growth than those in the non-LSIMCL group (M=10.34, s=1.64). In the non-LSIMCL group, there was a significant difference between achievement levels ($F_{2,60}$=3.38, p=.04). The low achievers in the non-LSIMCL group (M=16.37, s=14.26) had higher growth from the pretest than the medium achievers (M=10.57, s=4.18) and high achievers did (M=10.34, s=1.64). In the LSIMCL group, there was also a significant difference between achievement levels ($F_{2,58}$=20.07, p<.001). The low achievers in the LSIMCL group (M=38.88, s=8.77) had higher increase from the

pretest than the medium achievers (M=25.88, s=10.98) and high achievers (M=22.52, s=5.60) did. The results are shown in Table 2.

Table 2.

Tests of Simple Main Effects in Score Increase from the Pretest

Sources	*SS*	*df*	*MS*	*F*	*p*	
Level						
Low	4936.39	1	4936.39	35.67	<.001***	LSIMCL>Control
Medium	2555.94	1	2555.94	39.91	<.001***	LSIMCL>Control
High	1519.23	1	1519.23	87.31	<.001***	LSIMCL>Control
Error		37, 42, 39				
Group						
LSIMCL	3029.28	2	1514.64	20.07	<.001***	Low>Medium, High
Control	463.19	2	231.60	33.38	.04	Low>Medium, High
Error		58, 60				

Notes. *** $p < 0.001$; *SS* means Type III Sum of Squares; *df* means degree of freedom.

After examining learning styles and treatment group using two-way ANOVA. There was a statistically significant difference existed between treatment groups ($F_{1, 116} = 82.34$, $p < .001$) and the LSIMCL group (M=28.98, s=11.11) was higher than non-LSIMCL group (M=12.25, s=8.59). There was no statistically significant difference between learning styles ($F_{3, 116} = .06$, $p = .98$) nor interaction effect between treatment group and learning styles ($F_{3, 116} = .21$, $p = .89$).

LSIMCL and Learning Attitude

The Ebook Use Questionnaire regarding students' attitudes toward learning was administered at the end of the four weeks of study in order to answer Research Question 3. The survey includes six subscales: (a) eBook adaptability, (b) interaction, (c) learning satisfaction, (d) learning difficulty, (e) learning effort, and (f) learning attention.

Ebook Adaptability

The composite score of five questions was used to determine the extent to which the adaptability of the instructional materials. The range of the composite score was 5–25. There was a statistically significant effect of different treatment groups ($F_{2,118}$=51.61, p<.001, η^2=.30). The composite scores from the control group (M=15.61, s=.59) were lower than those in the LSIMCL group (M=21.63, s=.60). Moreover, there was no statistically difference between achievement levels ($F_{2,118}$=1.18, p=.31, η^2=.02). There was no significant interaction effect between treatment group and achievement levels ($F_{2,118}$=.73, p=.48, η^2=.01). The results are

shown in Table 3.

Table 3.

Survey-Adaptability, Interaction, and Satisfaction

Groups	Adaptability		Interaction		Satisfaction		N
	Mean	*s*	Mean	*s*	Mean	*s*	
LSIMCL							
Low	21.90	1.04	32.85	1.93	22.25	2.79	20
Medium	21.60	1.04	28.90	4.99	21.25	2.53	20
High	21.38	1.01	29.48	4.64	21.43	3.56	21
total	21.62	3.65	30.39	4.39	21.64	2.98	61
Non-LSIMCL							
Low	17.11	1.07	30.63	3.96	17.16	4.94	19
Medium	14.33	.95	27.33	4.03	13.17	6.84	24
High	15.40	1.04	28.29	3.30	12.65	2.39	20
total	15.51	5.44	28.29	4.04	14.21	5.48	63
Total							
Low	19.56	4.49	31.76	3.25	19.77	4.70	39
Medium	17.64	6.92	28.05	4.51	16.84	6.67	44
High	18.46	4.72	28.37	4.16	17.15	5.36	41
total	18.52	5.55	29.33	4.33	17.86	5.78	124

After examining learning styles and treatment group using two-way ANOVA. There was a statistically significant difference existed between treatment groups ($F_{1, 116}$ = 49.78, p < .001) and the LSIMCL group (M=21.62, s=3.65) was higher than non-LSIMCL group (M=15.51, s=5.44). There was no statistically significant difference between learning styles ($F_{3, 116}$ = .10, p = .96) nor interaction effect between treatment group and learning styles ($F_{3, 116}$ = .14, p = .94).

Learning Interaction

The composite score from seven questions was used to determine the students' perceptions of interaction. The range of the composite score was 7–35. There was a statistically significant effect of different treatment groups ($F_{2,118}$=8.08, p=.005, η^2=.06). The composite scores from the control group (M=28.39, s=.50) were lower than those in the LSIMCL group (M=30.41, s=.51). Moreover, there was a statistically difference between achievement levels ($F_{2,118}$=10.62, p<.001, η^2=.15). The post hoc test showed that low achievers (M=31.74, s=.63) perceived they had more interaction than those in the medium achievement (M=28.12, s=.60) and high achievement (M=28.34, s=.62) groups. There was no significant interaction effect between treatment group and achievement levels ($F_{2,118}$=.11, p=.90, η^2=.002). The results are shown in Table 3.

After examining learning styles and treatment group using two-way ANOVA. There was a statistically significant difference existed between treatment groups ($F_{1, 116}$ = 8.47, p < .001) and the LSIMCL group (M=30.39, s=4.39) was higher than non-LSIMCL group (M=28.29, s=4.04). There was no statistically significant difference between learning styles ($F_{3, 116}$ = 1.43, p = .24) nor interaction effect between treatment group and learning styles ($F_{3, 116}$ = .60, p = .62).

Learning Satisfaction

The composite score from five questions was used to determine the students' perceptions of satisfaction. The range of the composite score was 5–25. There was a statistically significant effect of different treatment groups ($F_{2,118}$=90.83, p<.001, η^2=.44). The composite scores from the control group (M=14.33, s=.54) were lower than those in the LSIMCL group (M=21.64, s=.55). Moreover, there was a statistically difference between achievement levels ($F_{2,118}$=4.89, p=.009, η^2=.08). The post hoc test showed that low achievers (M=19.70, s=.68) perceived they had more satisfaction than those in the medium achievement (M=17.21, s=.65) and high achievement (M=17.04, s=.67) groups. There was no significant interaction effect between treatment group and achievement levels ($F_{2,118}$=2.10, p=.13, η^2=.03). The results are shown in Table 3.

After examining learning styles and treatment group using two-way ANOVA. There was a statistically significant difference existed between treatment groups ($F_{1, 116}$ = 81.77, p < .001) and the LSIMCL group (M=21.64, s=2.98) was higher than non-LSIMCL group (M=14.21, s=5.48). There was no statistically significant difference between learning styles ($F_{3, 116}$ = .11, p = .96) nor interaction effect between treatment group and learning styles ($F_{3, 116}$ = .04, p = .99).

Difficulty of the Ebook

The score from Question 18 was used to determine the students' perception of the difficulty of the instructional material. The range of the score was 1–9. There was a statistically significant interaction effect between treatment groups and achievement levels ($F_{2,118}$=3.28, p=.04, η^2=.05). The results are shown in Table 4. Because the interaction effect is significant, tests of simple main effects were performed on the score according to achievement levels and treatment groups. In the control group, there was a significant difference between different achievement

levels ($F_{2,60}$=6.40, p=.003). The low achievement students in the control group (M=5.00, s=2.31) perceived the learning materials to be the most difficult than those with medium (M=3.00, s=1.56) and high achievement levels (M=3.80, s=1.58). In the LSIMCL group, there was no significant difference between achievement levels ($F_{2,59}$=1.26, p=.29). The low achievers (M=1.75, s=1.45) perceived the learning materials to be as difficult as medium achievers (M=1.40, s=.60) and high achievers (M=1.29, s=.64) did. In the low achiever group, there was a significant difference between treatment groups ($F_{1,37}$=28.05, p<.001). The low achievers in the non-LSIMCL group had higher difficulty (M=5.00, s=2.31) reading the e-book than those in the LSIMCL group (M=1.75, s=1.45). There was also a significant difference between treatment groups for the medium achievers ($F_{1,42}$=18.68, p<.001). The medium achievers in the non-LSIMCL group perceived the e-book to be more difficult (M=3.00, s=1.56) than those in the LSIMCL group (M=1.40, s=.60). Finally, there was a significant difference between treatment groups in the high achievement group ($F_{1,39}$=45.52, p<.001). The high achievers in the non-LSIMCL group had more difficulty (M=3.80, s=1.58) reading the e-book than those in the LSIMCL group (M=1.29, s=.64).The results are shown in Table 5.

After examining learning styles and treatment group using two-way ANOVA. There was a statistically significant difference existed between treatment groups ($F_{1, 116}$ = 67.48, p < .001) and the LSIMCL group (M=1.48, s=.98) was lower than non-LSIMCL group (M=3.86, s=1.97). There was no statistically significant difference between learning styles ($F_{3, 116}$ = .05, p = .98) nor interaction effect between treatment group and learning styles ($F_{3, 116}$ = .51, p = .68).

Table 4.

Survey-Difficulty, Effort, and Attention

Groups	Difficulty		Effort		Attention		N
	Mean	*s*	Mean	*s*	Mean	*s*	
LSIMCL							
Low	1.75	1.45	1.30	.47	2.35	1.63	20
Medium	1.40	.60	1.60	.75	3.40	1.67	20
High	1.29	.64	1.52	.68	3.38	2.73	21
total	1.48	.98	1.48	.65	3.05	2.11	61
Non-LSIMCL							
Low	5.00	2.31	7.21	.98	6.84	1.01	19
Medium	3.00	1.56	3.75	.90	4.29	1.68	24
High	3.80	1.58	3.35	1.76	4.25	1.65	20
total	3.86	1.97	4.67	2.09	5.05	1.90	63
Total							
Low	3.33	2.51	4.18	3.09	4.54	2.65	39
Medium	2.27	1.45	2.77	1.36	3.89	1.71	44
High	2.51	1.73	2.42	1.60	3.80	2.28	41
total	2.69	1.96	3.10	2.23	4.06	2.23	124

Table 5.
Tests of Simple Main Effects in Difficulty

Sources	*SS*	*df*	*MS*	*F*	*p*	*Note*
Level						
Low	102.92	1	102.92	28.05	<.001***	LSIMCL<control
Medium	27.93	1	27.93	18.68	<.001***	LSIMCL<control
High	64.76	1	64.76	45.52	<.001***	LSIMCL<control
Error		37, 42,39				
Group						
LSIMCL	2.38	2	1.19	1.26	.29	
Control	42.51	2	21.26	6.40	.003**	Low>medium, high
Error		59, 60				

Notes. ** $p < 0.01$,*** $p < 0.001$; *SS* means Type III Sum of Squares; *df* means degree of freedom

Effort of Reading the Ebook

The score from Question 19 was used to determine the students' perception of the effort they need when reading the e-book. The range of the score was 1–9. There was a statistically significant interaction effect between treatment groups and achievement levels ($F_{2,118}$=51.27, p<.001, η^2=.47). The results are shown in Table 4. Because the interaction effect is significant, tests of simple main effects were performed on the score according to achievement levels and treatment groups. In the control group, there was a significant difference between different levels ($F_{2,60}$=56.62, p<.001). The low achievement students in the control group (M=7.21, s=.98) perceived they need the most effort than those with medium (M=3.75, s=.90) and high achievement levels (M=3.35, s=1.76). In the LSIMCL group, there was no significant difference between achievement levels ($F_{2,59}$=1.17, p=.32). The low achievers (M=1.30, s=.47) perceived they spend similar effort when reading the medium achievers (M=1.60, s=.75) and high achievers (M=1.52, s=.68) did. In the low achiever group, there was a significant difference between treatment groups ($F_{1,37}$=589.68, p<.001). The low achievers in the non-LSIMCL group needed more effort (M=7.21, s=.98) reading the e-book than those in the LSIMCL group (M=1.30, s=.47). There was also a significant difference between treatment groups for the medium achievers ($F_{1,42}$=72.29, p<.001). The medium achievers in the non-LSIMCL group perceived they need more effort reading the e-book (M=3.75, s=.90) than those in the LSIMCL group (M=1.60, s=.75). Finally, there was a significant

difference between treatment groups in the high achievement group ($F_{1,39}$=19.66, p<.001). The high achievers in the non-LSIMCL group needed more effort (M=3.35, s=1.76) reading the e-book than those in the LSIMCL group (M=1.52, s=.68).The results are shown in Table 6.

After examining learning styles and treatment group using two-way ANOVA. There was a statistically significant difference existed between treatment groups ($F_{1, 116}$ = 134.82, p < .001) and the LSIMCL group (M=1.48, s=.65) was lower than non-LSIMCL group (M=4.67, s=2.09). There was no statistically significant difference between learning styles ($F_{3, 116}$ = .91, p = .44) nor interaction effect between treatment group and learning styles ($F_{3, 116}$=2 .61, p = .06).

Table 6.

Tests of Simple Main Effects in Effort

Sources	*SS*	*df*	*MS*	*F*	*p*	*Note*
Level						
Low	340.39	1	340.39	589.68	<.001***	LSIMCL<control
Medium	50.43	1	50.43	72.29	<.001***	LSIMCL<control
High	34.16	1	34.16	19.66	<.001***	LSIMCL<control
Error		37, 42,39				
Group						
LSIMCL	.98	2	.49	1.17	.32	
Control	177.79	2	88.90	56.62	<.001**	Low>medium, high
Error		59, 60				

Notes. ** p < 0.01,*** p < 0.001; *SS* means Type III Sum of Squares; *df* means degree of freedom

Attention Needed When Reading the Ebook

The score from Question 20 was used to determine the students' perceptions of how their attention was affected when reading the e-book. The range of the score was 1–9. There was a statistically significant interaction effect between treatment groups and achievement levels ($F_{2,118}$=13.25, p<.001, η^2=.18). The results are shown in Table 4. Because the interaction effect is significant, tests of simple main effects were performed on the score according to achievement levels and treatment groups. In the control group, there was a significant difference between different levels ($F_{2,60}$=19.44, p<.001). The low achievement students in the control group (M=6.84, s=1.01) perceived they were less focused than those with medium (M=4.29, s=1.68)

and high achievement levels (M=4.25, s=1.65). In the LSIMCL group, there was no significant difference between achievement levels ($F_{2,59}$=1.67, p=.20). The low achievers (M=2.35, s=1.63) perceived they spend similar attention when reading with the medium achievers (M=3.40, s=1.67) and high achievers (M=3.38, s=2.73) did. In the low achiever group, there was a significant difference between treatment groups ($F_{1,37}$=105.32, p<.001). The low achievers in the non-LSIMCL group needed more attention (M=6.84, s=1.01) reading the e-book than those in the LSIMCL group (M=2.35, s=1.63). There was no significant difference between treatment groups for the medium achievers ($F_{1,42}$=3.09, p=.09). The medium achievers in the non-LSIMCL group perceived they need similar attention reading the e-book (M=4.29, s=1.68) than those in the LSIMCL group (M=3.40, s=1.67). Finally, there was also no significant difference between treatment groups in the high achievement group ($F_{1,39}$=1.50, p=.23). The high achievers in the non-LSIMCL group needed to pay similar attention (M=4.25, s=1.65) when reading the e-book with those in the LSIMCL group (M=3.38, s=2.73).The results are shown in Table 7.

After examining learning styles and treatment group using two-way ANOVA. There was a statistically significant difference existed between treatment groups ($F_{1, 116}$ = 30.94, p < .001) and the LSIMCL group (M=3.05, s=2.11) was lower than non-LSIMCL group (M=5.05, s=1.90). There was no statistically significant difference between learning styles ($F_{3, 116}$ = .47, p = .70) nor interaction effect between treatment group and learning styles ($F_{3, 116}$ = 1.77, p = .16).

Table 7.
Tests of Simple Main Effects in Attention

Sources	*SS*	*df*	*MS*	*F*	*p*	*Note*
Level						
Low	196.62	1	196.62	105.32	<.001***	LSIMCL<control
Medium	8.67	1	8.67	3.09	.09	
High	7.74	1	7.74	1.50	.23	
Error		37, 42,39				
Group						
LSIMCL	14.55	2	7.28	1.67	.20	
Control	87.62	2	43.81	19.44	<.001**	Low>medium, high
Error		59, 60				

Notes. ** p < 0.01,*** p < 0.001; *SS* means Type III Sum of Squares; *df* means degree of freedom

Learning Experience

The data collected from two open-ended questions in the Ebook Use Questionnaire and face-to-face interview with six students in the LSIMCL group were used to answer Research Question 4. The common themes from students' comments in the survey are discussed below:

Benefit: The adaptive ebook is convenient, easy to use, and interesting.

A total of 86.89% of the participants agreed that the ebook was convenient for class discussions. They could bring iPads with them when discussing materials with their team members. They felt the adaptive ebook helped them sustain their attention and motivated them to learn more about the topic. Student 25 stated "the adaptive ebook was convenient and easy to operate. The content was also interesting and attracted my attention." Moreover, 78.69% of the students noted that the adaptive ebook was easy to read and understand. They could recheck the concepts or when sharing what they had learned with their group members. Student 43 mentioned that "the ebook was helpful to learn when I read the content and when I discussed with my group members." Only a short introduction is necessary before using adaptive ebooks in class. Finally, 75.41% of the students agreed that they learned from others in the learning process. Student 37 stated "discussing with team members help me understand others' ideas. I could teach others and also learn from others."

Drawbacks and Recommendations: Font size and discussion time.

Although using the adaptive ebook is easy and convenient, 34.43% of the participants claimed that the 12-point font was too small to read and recommended that the font size should be larger. Moreover, 24.59% of the participants felt that they needed more time for discussion with their team members when a disagreement occurred. More discussion time should be added to allow them to thoroughly discuss important topics and improve their understanding. Student 54 mentioned "discussion and getting the group to make a final decision took time. I wish I could have more time interacting with my team members."

Discussion

LSIMCL Improves Learning Performance

The purpose of this study was to investigate the effect of using LSIMCL in nutrition learning. The findings confirm that LSIMCL effectively facilitates learning nutrition in primary education. The LSIMCL group showed higher academic performance than the non-LSIMCL group when the pre-test score was controlled. Thus, integrating LSIMCL in learning helped improve the participants' academic performance. The finding is consistent with other research that integrating learning styles (Çakıroğlu, 2014; Chen & Chiou, 2014; Franzoni & Assar, 2009). The LSIMCL group had significant higher performance than those in the non- LSIMCL group. In the non-LSIMCL group, the low achievers had significant lower scores than medium and high achievers did, while there was no significant difference between achievement levels in the LSIMCL group. Gambari et al. (2014) declared that students with low ability remain at low performance levels in computer-mediated communication. Designing instructions according to students' learning style helps improve low achiever's learning and lower cognitive load resulted from mobile learning (Abdul-Rahman & du Boulay, 2014) discussed in the next section.

In both LSIMCL and non-LSIMCL groups, the low achievers had greater increase in their quiz scores than the medium and high achievers. Mobile cooperative learning may improve low achievers' learning in Jigsaw activities (Huang et al., 2008; Tsiasos et al., 2010). Moreover, the low, medium, and high achievers in the LSIMCL group all had greater growth in their scores when compared to the non-LSIMCL group. The learning style integrated mobile cooperative learning environment further improved their performance for different levels of achievers.

LSIMCL and Learning Attitude

The results from the learning attitude showed the low achievers had a more positive attitude toward interaction and learning satisfaction than the medium and high achievers did. The Jigsaw activity facilitated sufficient interaction in students' learning (Jacob, 1999; Slavin, 1999). The senses of interaction and satisfaction increased especially for the low achievers. Less social construction of knowledge

(Heo et al., 2010) and contribution (Serce et al., 2012) among low achievers were improved after adopting learning style into consideration. Moreover, there was a statistically significant difference in the composite scores between the LSIMCL and non- LSIMCL groups in their perceptions of the adaptability, interaction, and their learning satisfaction. In line with some previous studies of learning style improve learning quality to be more adaptable (Graf et al., 2010; Kinshuk et al., 2009) and learning attitude in student interaction (Brown et al., 2009), the LSIMCL learning environment further helped the students to learn according to their needs, improved their interaction with others, and enhanced their learning satisfaction.

The low, medium, and high achievers in the LSIMCL group reported less difficulty and effort when reading the learning material than those in the non-LSIMCL group. In the non-LSIMCL group, the low achievers reported to have more difficulty and effort when reading the ebook. However, the low achievers did not have more difficulty or need more effort than the medium and high achievers in the LSIMCL group. Contrast to the heavy cognitive load in mobile learning (Chu, 2014; Hwang et al., 2013; Liu et al., 2012), the learning materials designed based on students' learning styles may help decrease learners' cognitive load (Abdul-Rahman & du Boulay, 2014) and was especially beneficial for low achievers. Furthermore, the low achievers were more easily distracted than the medium and high achievers in the non-LSIMCL group while they had the similar level of attention with the medium and high achievers in the LSIMCL group. For low achievers in the LSIMCL group, they reported less distraction when reading the ebook than the non-LSIMCL group. Considering learning styles when designing instructional materials could help the low achievers to stay focused. To improve low achievers' learning effect and attitude, teachers should consider their learning style when preparing instructional materials (Garcia, de Caso-Fuertes, 2007).

From students' performance, learning growth, attitude, and cognitive load, there was no difference between learning styles in the LSIMCL environment. In contrast to an IMLBRS system with map-based guidance proposed by Chen (2013) to support cooperative PBL in a library environment, the results showed that the field-dependent learners get better performance than field-independent learners may because the former are interpersonal and like learning in groups. In this study, the dimensions of visual/verbal and sequential/global relate to content type and navigation behavior rather than communication preference may cause the difference.

Most students felt that LSIMCL provided an appropriate presentation and layout for them; moreover, reading the adaptive learning materials was interesting, convenient, and easy. This may explain that LSIMCL facilitates users' learning and provides them with appropriate learning environments according to their needs (Lan, et al., 2009). A font size larger than 12-point for the ebook text and more discussion time are recommended for more interaction and better understanding.

Limitations and Future Research

This study has some limitations. First, the data were collected from a sixth-grade health education course in an urban primary school in Taiwan; therefore, care must be taken when generalizing to other contexts. Experiments in other levels, subjects, or areas could be examined and compared in future research. Second, the participants were analyzed according to their achievement levels; future research may consider other factors such as age, sex, etc. to investigate whether their attitude and learning performance were influenced. Age may influence the effect brought from learning styles due to students have different reading abilities (Wang, Wang, & Liu, 2013). There were interactions found in the bimodal/multimodal learning styles and gender (Bolliger & Supanakorn, 2010). These relationships in the visual/verbal and sequential/global dimensions have not been fully examined. Lastly, this study examined the participants' learning performance and attitude immediately after the treatment. Further study could be conducted on the long-term impact on students' attitude and academic performance.

Considering applying appropriate pedagogy and instructional design when using new technologies is more important than utilizing a new technology itself. This study tried to combine cooperative learning, mobile devices, and learning styles into a primary health education class. The results showed that the LSIMCL environment improves students' ability as well as learning attitude. The LSIMCL environment helps low achievers improve their learning growth, interaction, satisfaction toward learning. The learning style integrated ebook also helped low achievers have less difficulty, effort, and distraction when reading the ebook. The results will be valuable for instructional designers to design appropriate instruction as well as learning materials and we sincerely wish that this study inspired the integration of suitable technologies and pedagogy to facilitate students' learning

especially for low achievers.

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專論

學習風格結合行動合作學習環境學習成效之研究

陳又菁

在結合科技的學習環境中，良好的互動是不可或缺的，而合作學習便常運用在教學當中以提升互動性，但傳統桌上型電腦並不完全適合運用在面對面溝通的情況，日益受到重視的行動載具提供了較為自然的互動環境，此外，電腦輔助溝通也被發現無法完全協助低成就者提升學習效果及互動程度，學習風格的導入對於影響行動學習所帶來的高認知負荷量具有潛力，因此，提供符合個人需求的適性化學習更顯重要。本研究發展了學習風格融入行動合作學習的環境(LSIMCL)，並與未考量學習風格的行動合作學習環境進行比較，及探討對於低、中、高成就者及不同學習風格者在學習成效及態度上的影響。結果顯示 LSIMCL 的學習成效高於控制組，低成就者的進步幅度最大；LSIMCL 組在適用性、互動性及滿意度上都較控制組高，且低成就者有較高的滿意度及互動性，控制組中的低成就者認為閱讀電子書有較高的困難度、需較高的心力及注意力，但 LSIMCL 中低成就者相較於其他程度者並無顯著差異；而各學習風格者之間在學習成效及態度上並無顯著差異，此結果對於結合行動合作學習及學習適性化之課程及教材設計將有相當的助益。

關鍵詞：行動合作學習、學習風格、拼圖法

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