Wang, Y.-H. (2017). The Effectiveness of Using Cloud-Based Cross-Device IRS to Support Classical Chinese Learning. *Educational Technology & Society, 20* (2), 127–141.

The Effectiveness of Using Cloud-Based Cross-Device IRS to Support Classical Chinese Learning

Yi-Hsuan Wang
Department of educational technology, Tamkang University, Taiwan // annywang12345@hotmail.com

(Submitted October 31, 2015; Revised April 28, 2016; Accepted August 3, 2016)

ABSTRACT

The purpose of the present study was to examine the effects of integrating a cloud-based cross-device interactive response system (CCIRS) on enhancing students' classical Chinese learning. The system is a cloud-based IRS system which provides instructors and learners with an environment in which to achieve immediate interactive learning and discussion in the classroom. A quasi-experimental design was employed in which the experimental group (E.G.) learned classical Chinese with the system, while the control group (C.G.) followed their original learning method. The results revealed that the novice and medium-achievement learners in the E.G. performed significantly better than other E.G. students, and most students as well as the instructor gave positive feedback regarding the use of the system for course learning. In sum, CCIRS is an easy-to-use learning trigger that encourages students to participate in activities, arouses course discussion, and helps to achieve students' social and self-directed learning. The study concludes that the idea of "bring your own device" could be implemented with this system, while integrating educational factors such as game-based elements and competitive activities into the response system could reinforce flipped classroom learning.

Keywords

IRS, Cloud-based application, Chinese learning

Introduction

How to host and create interaction among students and teachers in class has always been an important challenge for course instructors (Pond, 2010; Wang, 2015). For the past few decades, technology-enhanced learning tools such as the Clicker technology (Lin, Liu, & Chu, 2011), the Interactive Response System (IRS) (Pond, 2010) or mobile-based applications for interactive response learning (Chuang, 2015; Stowell, 2014) have helped teachers overcome these challenges and have promoted students' engagement and learning interaction in class. The basic components of the above-mentioned technology are hand-held transmitters and receivers that are used for delivering and receiving responses between teachers and learners, and software installed on teachers' computers to present students' responses to questions (Pond, 2010). The use of Clickers, IRS or interactive applications has the advantage of motivating participants to become more engaged than when such systems are not used in the classroom (Heaslip, Donovan, & Cullen, 2013) while real-time interactive systems help learners achieve better learning performance (Pond, 2010). Research has also indicated that adopting a student response system in the classroom benefits learners' engagement, motivation and learning (Wang, 2015), and the use of IRS can play a key role in delivering pedagogical outcomes that motivate students to become more attentive and involved in class (Heaslip, Donovan, & Cullen, 2013). Nevertheless, there are some limitations to the above-mentioned educational technology tools (Clicker, IRS and App-based systems) including the effort required to administer the system environment (Barber et al., 2007), the cost of special devices such as clickers (Boatright-Hortwitz, 2009), the price of installing specific interactive software (Keough, 2012), the time cost of setting up the IRS environment in the limited class time (Keough, 2012), and teachers' need for particular technology skills training before adopting the technology in their classrooms for both software and hardware installation (Wang, 2015). However, the most important problem is that each brand of clicker or mobile-based IRS application only accepts particular information sending devices (Stowell, 2014), meaning that if an IRS App is developed for smartphones, learners could not send information from computer-based equipment, or if the IRS App is developed for the iOS system, learners with Android phones could not participate in the IRS activity.

Chinese teaching in school includes modern and classical Chinese learning. The purpose of Modern Chinese learning focuses on language skills for daily use, while the Ministry of Education in Taiwan (Ministry of Education, 2013) announced that the purpose of classical Chinese learning is to promote students' abilities of classical Chinese culture learning, reading comprehension, appreciation and learning motivation. Research has indicated that through the comprehension and memorization of classical Chinese, learners improve their capability of reading and writing modern Chinese (Chen, 2003). However, the wording and sentence construction of classical Chinese are much more complicated than in modern Chinese, so how to engage senior high students' motivation for classical Chinese learning in lecture classes, and further, how to encourage students to achieve self-directed learning are still issues that need to be explored (Chiang, 2014).

Research purpose and questions

Several studies have investigated the potential use of interactive learning technology in fostering learning (Pond, 2010, Wang, 2015); however, there are some limitations of IRS, especially for cross-device usage, and the setup fees of the hardware and software system environments are high (Barber et al., 2007). To date, not many studies have made attempts to address the effectiveness of integrating cloud-based techniques to assist learning. Consequently, the purpose of this study was to integrate a cloud-based and cross-device interactive response system into a formal classroom, and to explore whether the assistance of this advanced learning technology could promote students' learning performance, and further, whether it could achieve self-directed learning purposes. Based on the above rationale, the following research questions were investigated: (1) Could CCIRS promote learners' classical Chinese learning performance? (2) How do the learners and instructor perceive the use of CCIRS for conducting learning activities? and (3) Does the integration of CCIRS form a different classroom teaching and learning pedagogy?

Literature review

Interactive response systems for educational applications

The IRS adopts specific connecting devices such as Clickers as learning tools to facilitate students' involvement in class (Pond, 2010). Clickers are a kind of device which can immediately deliver learners' feedback to instructors, and can help teachers control and understand students' learning situation. Mayer et al. (2009) adopted a quasi-experimental approach which integrated the use of clickers into a large lecture course in college. The instructors in the clicker group handed out learning sheets, and students used a hand-held remote control device to answer the questions. In the no-clicker group, instructors passed out a sheet containing questions and asked students for a raise of hands for each alternative answer. The findings revealed that the students in the clicker group were more cognitively engaged while learning (Mayer et al., 2009).

Pond (2010) used an interactive response system to improve college students' performance in an introductory psychology course, and revealed that the students who used the interactive system achieved higher test scores than those who did not. Chuang (2015) developed a mobile-based interactive response system to encourage students to engage in a programming course, and his results pointed out that the mobile-based IRS system triggered collaborative and active learning. Besides, Scrowell (2014) suggested that when using the mobile-based IRS application in the classroom, the class had to have sufficient Wi-Fi access or Internet bandwidth, otherwise the learners might have problems connecting to the IRS server, resulting in negative learning effects.

Overall, the use of IRS applications has the potential to improve classroom learning, and learners tend to have more strongly positive feedback when instructors combine IRS with their teaching or learning strategies (Caldwell, 2007) such as peer learning (Hake, 1998), cooperative learning (Nichol & Boyle, 2003) or the game-based competition learning strategy (Wang, 2015) with IRS applications.

Strategy to foster learning: Game-based strategy with competition

Prensky (2001) stated that teaching with game strategies could address the pitfalls found in traditional education, while Kapp (2012) defined gamification as "using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems." Games have the power to get learners to learn enthusiastically, and the repetition in gameplay is the driving force that motivates learners to search for target knowledge through the chance to learn by playing (Coyne, 2003). Several studies have explored the pedagogical value of using game elements such as "game-based competition" and a "game-based ranking list" (Huang, 2013; Wei, 2013). For example, Wei (2013) and Huang (2013) pointed out that adopting a competitive mechanism in game activities inspired students' learning motivation, and the competitive activities has the potential to foster learning and help students concentrate more in class. The factor of beating other competitors in the game is a trigger that can push students to study hard and concentrate on the educational contents (Wang, 2015). Wang (2015) further stated that integrating a game-based element into IRS may have the potential to support flipped classroom learning. Flipped classroom instruction encourages students to study course materials prior to the class, and teachers shift their role from being instructors to information givers (Pardo et al., 2012). Several studies have proposed that the integration of a gameplay element into IRS facilitates the application of flipped classrooms (Chen, Worden, & Bradley, 2015; Davies, Dean, & Ball, 2013) because the game activities and competitive factor have positive effects in terms of triggering students to read the textbook before class in order to get better game results in the activity. Despite the argument that the integration of a competitive factor into game activities may foster effective learning (Chen & Chen, 2013), there are a few researchers who are concerned that competition in learning may be hurtful or may have negative influences on learners due to their lack of confidence and the social comparison that could result from the learning pressure it creates (Stapel & Koomen, 2005).

Meanwhile, the advantage of the use of a game-based activity is that it helps instructors deliver important topics, and assists learners in remembering the knowledge through the repeated game activities (Wang, 2015). Research had indicated that adopting game-based approach in learning fostered students' social learning (Tan, Goh, Ang, & Huan, 2013). In social learning theory, students learn by observing others and modify their own behavior accordingly (Bandura, 1977). The game-based activity might be a good learning scenario for learners to involve themselves and learn things through the interaction with peers (De-Marcos, Garcia-Lopez, & Garcia-Cabot, 2016). A number of studies have adopted the interactive response learning system together with game elements in educational scenarios (Méndez, & Slisko, 2013; Wang, 2015). For example, the Quizlet website (Gruenstein et al., 2009) adopts a game element in collecting learners' instant feedback, and helps teachers to create and employ a variety of online activities in class for fostering learning. Socrative (Méndez, & Slisko, 2013) provides a real-time facility to collect data from students, and offers games to encourage students to answer questions to pass game levels. Van Eck (2006) has stated that learning quality is maximized by leaving the game design of learning up to the teachers, and researchers believe that educational games could be learning aids used as reinforcement to support traditional learning (Tsai, Yu, & Hsiao, 2012) because the games can lower anxiety, enhance involvement, and make learning acquisition more likely, especially for low-achieving students (Young & Wang, 2014). Gamification in educational scenarios helps learners think and learn through game activities, and gamification with competitive activities can motivate learners to be more active participants in the learning process, and thus leads to improvement in knowledge and skills that the learners may not even be aware of (Kiryakova, Angelova, & Yordanova, 2014).

Advanced learning technology enhances Chinese learning

Chinese is an important academic subject in several Asian countries, and how to engage students to achieve self-directed learning in lecture classes is an important goal for all Chinese teachers (Chiang, 2014). When teaching Chinese, teachers first provide edification for learners by leading them to understand and appreciate the language. The ability of Chinese article appreciation is achieved by training and enlarging learners' Chinese characters and vocabulary. After acquiring the form of single characters and vocabulary, teachers gradually lead students to learn the meanings of Chinese contexts, rhetoric and then entire articles (Chi & Chiou, 2015; Chang, 2010). Chinese learning is a multi-phased process (Chi & Chiou, 2015), and researchers have indicated that using advanced educational learning technology can benefit Chinese learning (Chen & Chou, 2007; Chang et al., 2010). For example, Chen and Chou (2007) adopted tablets as learning aids to help students learn Chinese through ubiquitous learning. Hsieh et al. (2010) used the situation learning strategy to help elementary students learn Chinese writing. Chang et al. (2010) developed a Wireless Handheld System to assist senior high school students improve their Chinese reading ability. Their system recorded students' learning paths and helped Chinese teachers to control the learners' learning situation. The results indicated that the WHS improved students', especially novice learners', Chinese reading ability. Edge et al. (2011) used mobile devices to help learners acquire Chinese characters; Tam and Cheung (2012) employed the i-Write system to support non-native Chinese speaking learners to acquire the correct writing sequence for Chinese characters. Liu, Owen and Sunderraman (2011) developed a flash-based system with a game-based strategy to assist non-native Chinese speakers learning Chinese characters. Sams and Bergmann (2013) developed a note-taking tool that integrated a cooperative learning strategy, the Sharing Unique Reading Feeling system, to help elementary school students acquire Chinese reading skills. These related studies indicated that adopting advanced learning technology fosters Chinese learning; however, not many studies have investigated how learning technology can help with classical Chinese learning.

The above-mentioned studies, which adopted interactive systems to foster learning using questioning in large lecture classes, and gamification and competition factors to assist students' learning, have individually shown positive effects on fostering students' learning. Nevertheless, few studies have discussed the cloud-based interactive response system with game-based elements and competitive activities for assisting students' classical Chinese learning. Thus, the aim of the study was to adopt a cloud-based and cross-device interactive response system in course teaching, and to investigate whether the combined learning strategies could foster students' language learning, and further, help the students achieve self-directed learning.

Introduction of CCIRS

The system adopted in this study was developed by the team, Kahoot!AS, composed of Johan Brand, Jamie Brooker and Morten Versvik from the Norwegian University of Technology and Science (Figure 1). In this system, instructors can adopt a variety of learning media to create online quizzes (Figure 2). The system supports mobile-based and computer-based web interfaces. The process of using the system starts from the teachers presenting and running the activity projecting questions onto the screen at the front of the classroom. Students can then access the website through personal devices by entering the PIN code (provided by the teacher) and will then see their name appear on the front screen. The system supports competitive and game-based pedagogy. In the activity, the learners play against each other and at the end of each question, students are shown a summary and game-like scoreboard, highlighting the names of the students or groups with the highest scores.

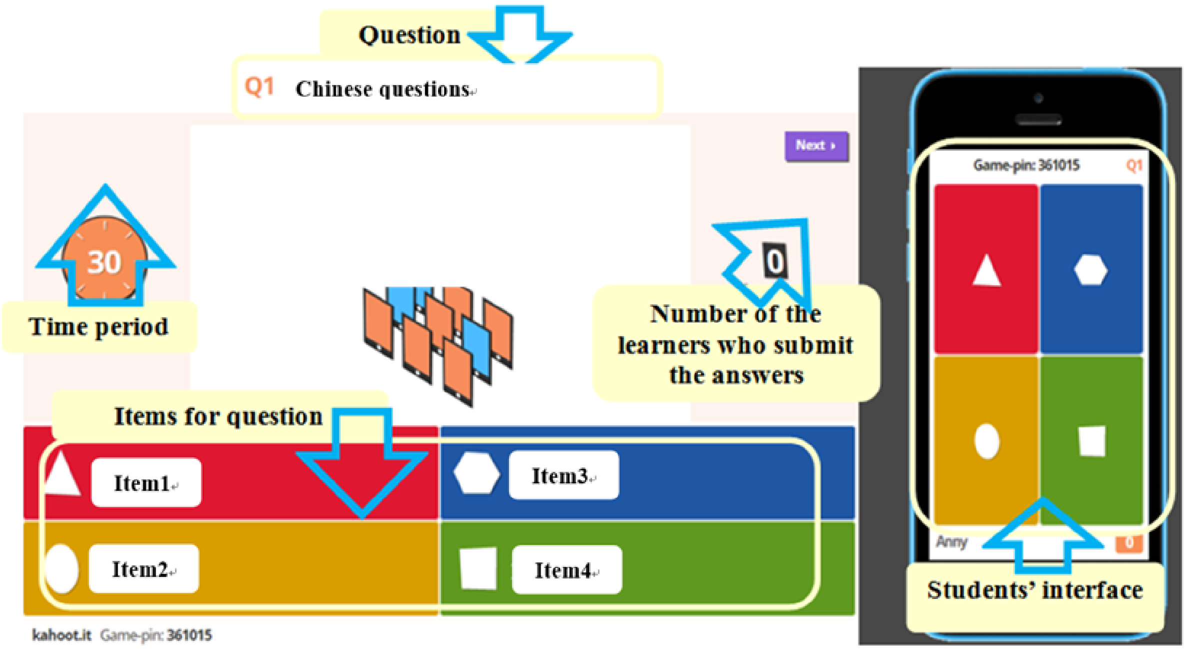


Figure 1. Demonstration of the system interface (from Kahoot!AS https://getkahoot.com/)

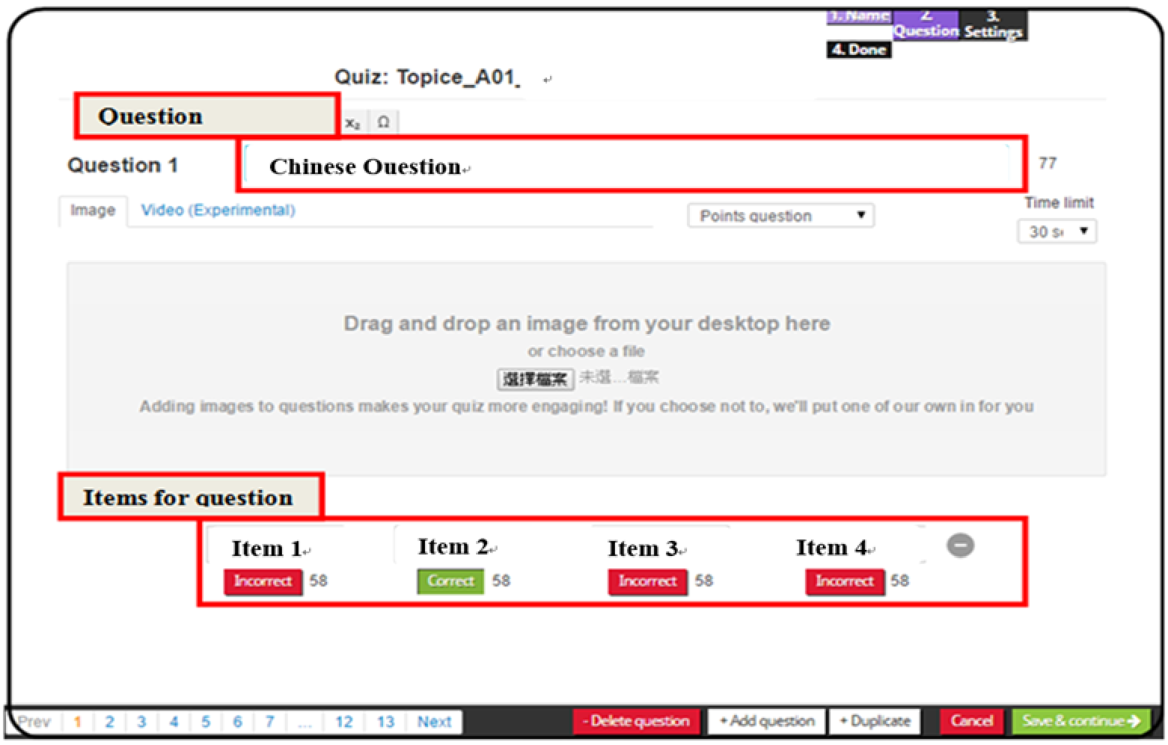


Figure 2. Teacher interface for creating a question (from Kahoot!AS http://getkahoot.com/)

Methodology

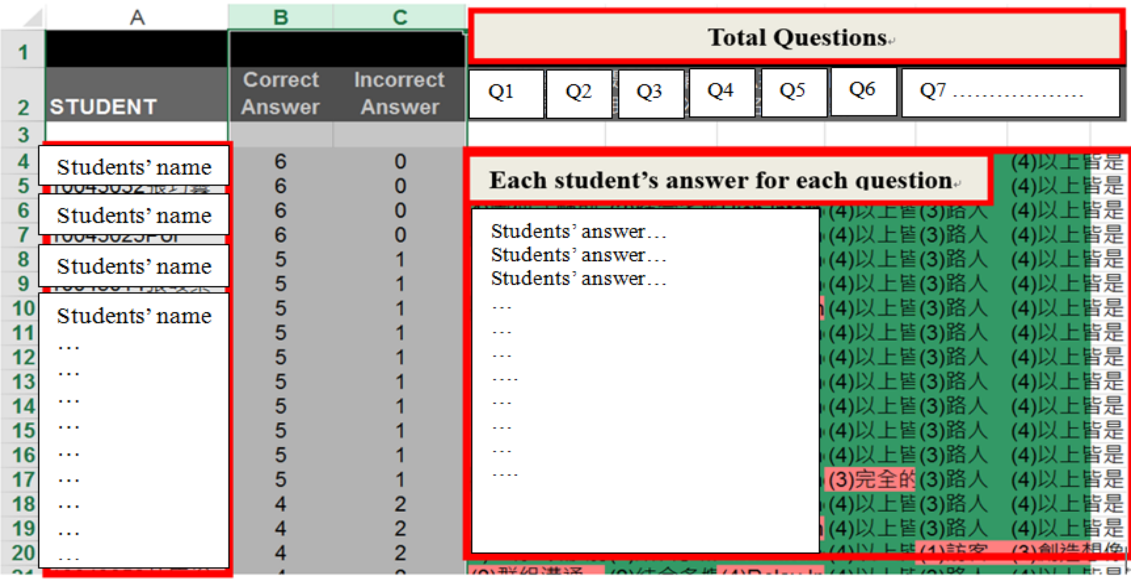
In this study, comparative test data were adopted to report on the performance of learning classical Chinese in two learning scenarios, with and without CCIRS, and both qualitative and quantitative approaches were employed. The duration of the data collection was four weeks. The learners in the experimental group (E.G.) learned classical Chinese with the assistance of the system, while the control group (C.G.) followed the original classical Chinese teaching method in which the teacher gave lectures and adopted paper-based worksheets to understand students' learning acquisition. In order to explore how the system facilitated the learners' classical Chinese learning, the researcher conducted a paper-based Chinese test before and after the experiment as the learning pre-test and post-test. After the experiment, questionnaires were administered to collect the learners' feedback, and the Chinese instructor was invited to participate in individual interviews to gather qualitative data to support the quantitative information derived from the questionnaire and pre- and post-tests.

Participants

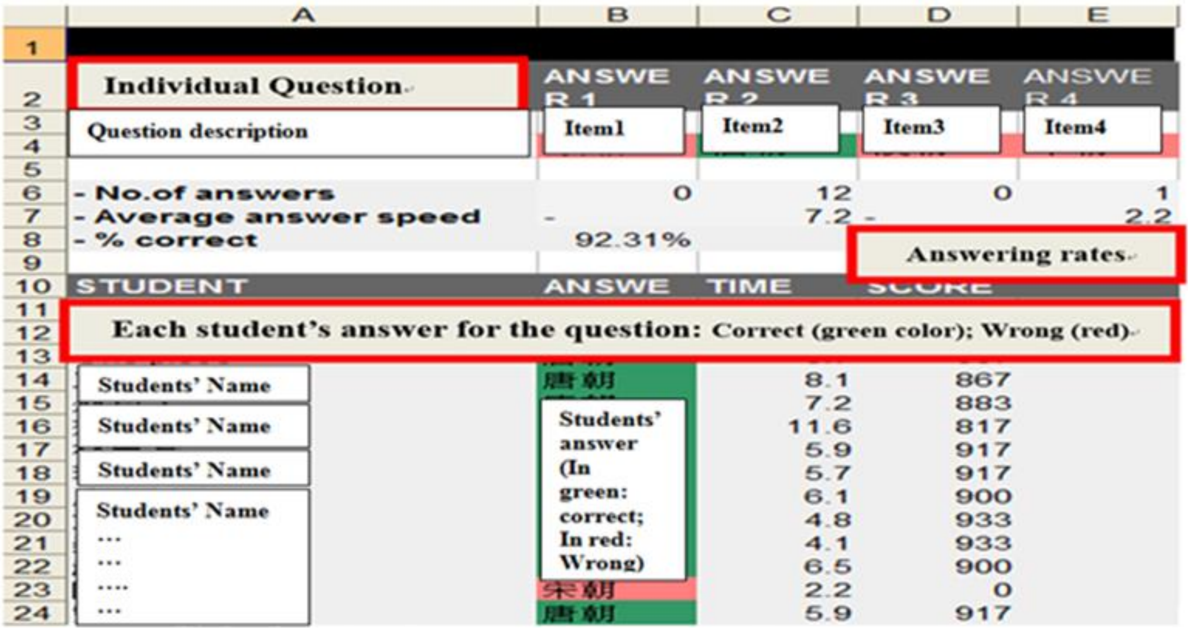
A total of 80 eleventh graders from a senior high school participated in this study and were divided into two groups (E.G. = 40 and C.G. = 40). These two groups of learners had the same Chinese teacher. Learners in both groups were further divided into three subgroups based on their Chinese grades of the previous semester. The grades of the previous semester were the mean values from three Chinese proficiency tests of the last semester. The group of advanced learners were those students whose grades were in the top one third of the class. The grades of the novice learners were in the bottom third of the class, and the rest of the students were categorized as intermediate learners.

The experiment

The duration of the experiment was four weeks. The Chinese instructor asked the learners in the two groups to preview the learning units before the class. Then, during the E.G.'s formal class time, the instructor gave lectures and adopted CCIRS to assist teaching and learning (Figure 4). Using CCIRS, the teacher created time-controlled activities for the students to answer questions. The students answered these questions with their own learning devices. After each activity, CCIRS immediately provided the teacher with a detailed report as an Excel file which included an overview of students' answers to questions such as how many questions they had answered correctly and their total scores (Figure 3). The detailed report could be viewed as students' learning portfolios which helped the teacher to know how much the learners in the classroom understood of the learning content so that she could emphasize the content that the learners had failed to grasp. On the other hand, the instructor of the C.G. used paper-based worksheets to test the students' learning acquisition. The items on the learning sheets for the C.G. were the same as those in the system for the E.G.



(a) Students' performance in all activities



(b) Students' performance for single question in an activity

Figure 3. Print-screen of detailed report provided by the system (from Kahoot!AS http://getkahoot.com/)

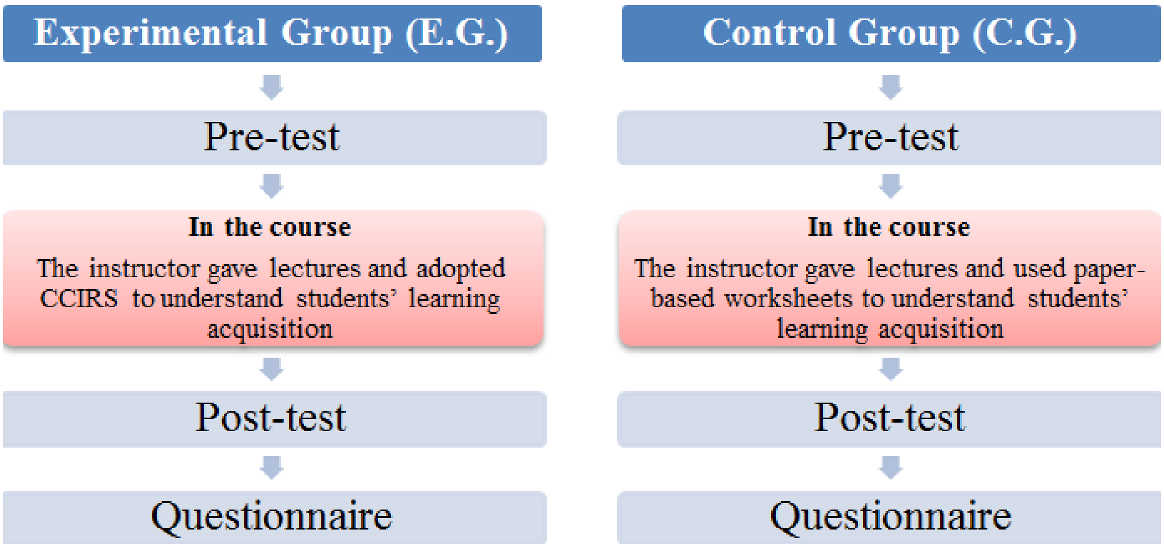
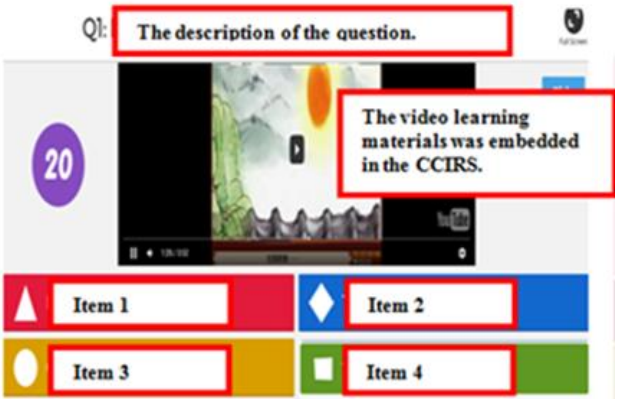


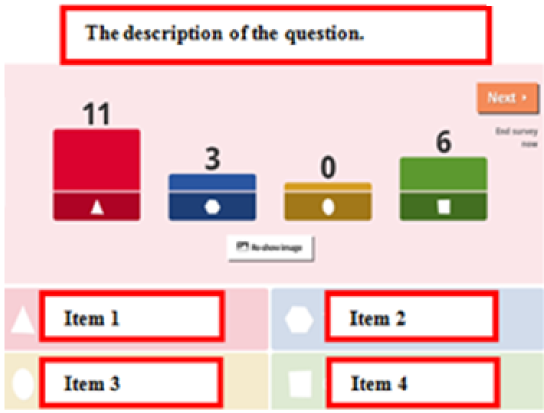
Figure 4. The experiment process for E.G. and C.G.

The activity on CCIRS in the classroom

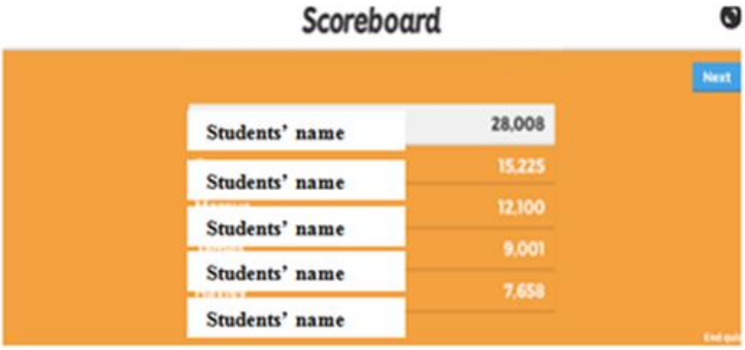
The students accessed the given website through their personal devices for entering the activities of CCIRS. There were several learning questions in each activity, and the teacher could embed multimedia contents such as visual combinations and audio objects as question items to present the learning context according to the classical Chinese learning contents (Figure 5). The learners in the activity could acquire the knowledge of classical Chinese literature and the meaning of classical Chinese vocabulary through multimedia materials. During the activity, the learners read the questions on the big screen at the front of the classroom and then chose the right answers to the items. At the end of each question, the teachers were able to view learners' performance immediately and the system listed the top five winners who answered the question correctly and in the shortest time. The students were motivated to answer questions as quickly as possible in order to move up the on-screen leader board and had their name displayed at the top.



(a) The multimedia contents in the CCIRS



(b) The immediately learning performance of the learners in CCIRS



(c) The top five winners in the activity

Figure 5. The demonstration of the activity (from Kahoot!AS http://getkahoot.com/)

Pre-test, post-test, questionnaire and interview

The pre-test and post-test consisted of multiple-choice questions and short answer questions related to the background knowledge of the targeted Chinese lesson. The items in the pre-test and post-test were validated by the cooperating Chinese teacher. The total score of the test was 100. The perceived learning scales of the questionnaires were modified based on the questionnaire from Carreira's study for evaluation of students' language learning motivation and attitudes (Carreira, 2006). The questionnaires in this study consisted of items on a five-point Likert scale and open-ended questions, and the Cronbach's α of the measures of the questionnaire was 0.91. In order to understand the instructor's perceptions, opinions and experience of using the system for teaching, the Chinese instructor was invited to take part in an individual focused interview for about an hour (Table 1).

Table 1. Interview questions for the instructor

Questions
• Please share your feedback on using CCIRS in your course.
• Please share your opinion on the adoption of the CCIRS system to assist students' classical Chinese learning, and whether using CCIRS could facilitate Chinese learning? Why and how?
• Please share your findings with us about how the learners' behavior changed when you used the CCIRS system in your classroom?
• What differences did the use of CCIRS bring to the classroom?
• What are your suggestions about using the CCIRS system for further courses?
• What advantages and disadvantages did the use of CCIRS bring to the classroom?

Data analysis

After deleting the invalid data, the total number of participants was 64 (E.G. = 28 and C.G. = 36). The descriptive statistics, independent *t*-tests and ANOVA test were adopted for quantitative analysis. For the qualitative data, each participant was given a code. For example, in the code EG-H-01, "EG" represents the experimental group, "H" stands for advanced learners, and "01" is the student number. The researcher translated the students' open-ended question feedback to raw data files and re-coded the raw data according to different themes. The final qualitative data were organized and displayed as reduced data from which the findings for each question could be highlighted, as well as for triangulation purposes.

Learning performance of the two groups

The pre-test and post-test were analyzed to answer the first research question. The results of the Levene's test confirmed that the data met the equality of variance assumption (p = .16 ≥ .05). Both groups showed improvement from the pre-test to the post-test, but the participants did not show significantly better performance in the post-test according to the analysis of independent sample *t*-tests (Table 2). The ANOVA test with post-hoc comparison was adopted to analyze the students' performance according to their learning achievement levels. The Table 3 revealed that the factor of various learning achievement levels influenced the students' learning performance. After doing further factor comparison analysis, it was found that the novice and medium-achievement learners in the E.G. improved significantly in the post-tests, while the advanced learners didn't showed significant improvement. This indicates that the novice and medium-achievement learners in the E.G. with CCIRS improved significantly in their classical Chinese post-test.

Table 2. Independent Samples *t*-test of the two groups

Post-test	*t*-test for equality of means					
	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI of difference	
					Lower	Upper
Equal variances assumed	1.432	.157	5.321	3.716	-2.105	12.746
Equal variances not assumed	1.536	.123	5.321	3.404	-1.481	12.122

Table 3. Results of the ANOVA tests of learners of various achievements in the two groups

Tests of between- subject effects			
	Mean square	*F*	*p*
Correct Model	878.980	8.337	.000
Intercept	226920.904	2152.33	.000
Groups	412.158	3.909	.053
Learning achievements	1472.122	13.963	.000
Groups * Learning achievements	375.183	3.559	.035
Error	105.430		
Total			
Multiple comparison			
Learning achievement and groups	Mean difference	Std. error difference	*Sig.*
Advanced learners E.G. C.G.	-4.788	4.614	.304
Medium-achievement learners E.G. C.G.	10.179^{*}	4.452	.026
Novice learners E.G. C.G.	10.082^{*}	4.486	.028

Note. $^{*}p < .05$.

Students' perceptions of using CCIRS for classroom learning

The data from the questionnaires regarding learners' feedback on using CCIRS were analyzed to answer the second question. The overall questionnaire results indicated that the learners were positive about using the system for class interaction (Table 4:Q1) and most of the students reflected that the operation of CCIRS was quite easy (Table 4:Q8). The statistical data from the self-report questionnaires also revealed that the learners liked to participate in the CCIRS activities for classical Chinese learning. Most of the students hoped that the teacher could keep using the system in the following classes (Table 4:Q5&Q18). They highly agreed that the use of the system promoted their interaction with their peers and with the instructor (Table 4:Q14&Q15), and the students expressed their hope that they could use CCIRS for other course subjects (Table 4:Q18). Besides, according to the questionnaire data, the students looked forward to participating in the CCIRS group activities (Table 4:Q17).

Table 4. Learners' feedback on CCIRS

	Items	Total	AL	IL	NL	P
Q1	I enjoyed using the system in the classical Chinese course	4.50	4.83	4.57	4.50	.758
Q5	I hope the teacher could keep using the system for Chinese class.	4.23	4.67	4.57	4.11	.501
Q8	The operation of the system is quite easy.	4.33	4.67	4.36	4.44	.851
Q12	I would use a nickname to represent myself in the system competition.	4.30	4.33	4.36	4.50	.845
Q13	The atmosphere becomes livelier in class with the use of the system.	4.60	4.67	4.57	4.72	.731
Q14	The use of the system enhances the interaction between classmates.	4.47	4.67	4.36	4.67	.672
Q15	The use of the system enhances the interaction between the teacher and me.	4.10	4.33	4.00	4.44	.486
Q16	I would like to participate in the activity personally.	3.17	4.17	3.07	3.67	.453
Q17	I would like to participate in the activity in a group.	4.27	4.33	4.43	4.39	.810
Q18	I look forward to the Chinese course because of the adoption of the system in the course.	4.07	4.50	4.00	4.33	.648
Q19	I would like to take part in activities in other subject courses.	4.40	4.67	4.36	4.56	.812

Note. AL = Advanced learner; IL = Intermediate learner; NL = Novice Learner.

Table 5. Learner's qualitative feedback on CCIRS

	Learners' feedback on the CCIRS (Advantages)		Learners' feedback on the CCIRS (Disadvantages)
N.L.	Everybody in the class was crazy about the activity. The course became quite interesting (EG-L-01). I wanted to get good scores so I studied more (EG-L-02). I think it was good! I don't like to only "read the book" and I like the activity. The atmosphere was vivid and I had interaction with my classmates (EG-L-03). It made me want to do the preview because I wanted to win the game (EG-L-04). I was more patient of reading the items on activity (EG-L-05). I usually do not like to read the items on the text because the items were too long to read. However, I was more active in activity (EG-L-06).	N.L.	*I felt pressure when the system started to countdown during the activity (EG-L-07).* *Sometimes, my cellophane was crashed and I couldn't participant in the activity (EG-L-08).* *Sometimes, the class was out of control (EG-L-09).* *The classroom was full of noise (EG-L-10).*
I.L.	The activity was exciting and it triggered me to preview the learning contents (EG-M-01). I will do the preview because I don't know when the teacher will give us activity (EG-M-02). It was good and I did the preview for the activity (EG-M-03). Participating in the activity made me to read more details in the book (EG-M-04). It was nervous, exciting and impression. I had interaction with lots of classmates (EG-M-05). It made me awaken in the course (EG-M-06).	I.L.	*It was a little noisy during the activity (EG-M-07).* *The schedule of the class was delayed (EG-M-08).*
A.L.	This was my first time to participate in the activity and it was really good (EG-H-01). The system was good and I could remember more important points during the activity (EG-H-02). The activity was quite impressed (EG-H-03).	A.L.	*The answer items (O, X) in the system were sometime hard to recognize (Only color and figure) (EG-H-04).*
Learners' suggestions regarding the system			
	It will be better if we could change the answer (within the given time) (EG-L-9). *No suggestion. It is good now (EG-M-10).*		

*Note. A.L. = Advanced learner, I.L. = Intermediate learner, N.L. = Novice Learner.

Moreover, according to the open-ended questions, the students reflected that participating in the CCIRS activities in the course was quite exciting and it enhanced their motivation to preview the learning contents. They had good interaction with their peers, and it further promoted their social interaction. The atmosphere in the course was lively, although a few students pointed out that it was noisy and sometimes the class was out of control during the activities (Table 5).

Instructor's perceptions of adopting CCIRS for teaching and learning

The researcher coded and organized the Chinese instructor's interview feedback regarding adopting CCIRS in the course activity. The instructor reflected that learners became more confident and concentrated on the course activity, especially the novice learners (Table 6-1). The teacher explained that before the experiment, the novice learners always felt bored or even fell asleep during class; however, they were excited and looked forward to the CCIRS activity every time, and they wanted to share what they had read and studied with each other. Moreover, they became eager to learn or preview the educational contents in order to get good scores on the CCIRS activity (Figure 6-2). The instructor commented that the adoption of CCIRS is a good method for triggering self-study. The atmosphere in the class became energetic, and the learners were very positive about participating in the CCIRS activities. The use of CCIRS therefore clearly has potential for assisting teachers in conducting the flipped classroom strategy.

The instructor also gave suggestions about improving the use of CCIRS such as enhancing the student interface by adding the corresponding name of each answer item so that the system could directly go through all the questions at once without pausing between each question (Table 6-1). Besides, the instructor mentioned that not every class should incorporate CCIRS activities because it takes a great deal of time, and may thus result in learning schedule delay.

Table 6. Summary of the interview feedback from the Chinese instructor

1. Feedback regarding using CCIRS in the course

- Using the system in the course is fine, but not in every single class, because when I am in a hurry with the course schedule, the use of the system may take too much time (**From interview Question 1**)
- The atmosphere in the class became vivid with the use of the system. Students had a chance to interact with each other, and they clarified the concept through the discussion (**From interview Question 2**).

2. Feedback regarding students' learning performance with the use of the CCIRS

- It is quite a good learning method and the learners were very positive about participating in the activity **(From interview Question 2)**.
- The low-achievement learners were engaged in the course with the assistance of the system, and before they usually felt bored or even fell asleep in the course; however, they became active in answering the questions in in order to get better scores in the activity **(From interview Question 3)**.
- The students, especially the low achievement ones, became more confident in learning **(From interview Question 5)**.

3. Suggestions for system modification and instruction applications

- **For system modification**
  - The current interface of the for teachers is good, and it is easy to input the question items in the system, while the interface for students could be improved by adding the name of each answer item instead of only using colors to represent the answer items **(From interview Question 4)**.
  - Just one suggestion. It would be better if the process of answering questions in the system could directly go through all the questions at one time without pausing between each question. I would like to explain and have discussions about each question at the end of the activity, and I think that would also help the students concentrate on the contents**(From interview Question 4)**.
- **For instruction applications**
  - Not every student has a learning device or an Internet connection, and thus it is suggested that the learners be encouraged to participate in activities in groups **(From interview Question 1)**.

Discussion

The use of the cross-device response system facilitates classroom teaching and flexible learning

The use of CCIRS enables instructors and students to overcome the previous hardware and software limitations of IRS. Students using any Internet-connected device with a web browser could participate in the classroom activities immediately. Before, when an instructor wanted to adopt IRS in the classroom, he/she had to make sure each student had available connecting devices, and the use of the IRS might be limited to a particular brand or mobile operating system. Besides, it took teachers and students extra time to get familiar with the hardware and software tools and to set up the connecting environment prior to the course (Barber et al., 2007). However, the characteristics of the cross-device usage of the CCIRS system enabled students and teachers to access the system more flexibly through various and easily accessible devices. CCIRS reduces the cost burden for students, and the friendly user interface facilitates instructors' willingness to use the system because there is no need for pre-training in administering the system. Meanwhile, the researcher also noticed that when using mobile devices for IRS course participation, the class has to have sufficient Wi-Fi access, otherwise the learners might have problems connecting to the IRS server, resulting in a negative effect for learning. This finding echoes Stowell's (2014) previous study findings which indicated the importance of providing learners with sufficient Internet bandwidth to foster IRS activity.

Game-based competitive activities in CCIRS fosters flipped classroom teaching and learning

According to the data analysis of the student questionnaires and teacher interview, it was found that the learners were willing to do the preview study in order to achieve good competition results. Such a system can thus be successfully used to motivate students to study the material before class. This finding echoes the results of Huang and Soman (2013) and Kiryakova, Angelova, and Yordanova (2014) which suggested that gamification with competition motivates learners to more actively participate in the learning process. The students reflected that competitive activities with the system enhanced their learning motivation and hence aroused their interest in reading the educational contents prior to the course. The findings of the study also suggest that adopting an interactive response system with the game-based competitive strategy would support flipped classroom teaching. Researchers have indicated that the flipped classroom method facilitates learning by encouraging students to prepare for classes and by providing them with opportunities to gain knowledge before class (Brame, 2013) and in this study, the researcher found that using CCIRS technology with game activities could foster the application of the flipped classroom approach and also promote student-centered learning (Fardoun et al., 2014). The results are also in accordance with Wang's study (2015) which concluded that interactive response learning has the potential for facilitating flipped learning because the immediate learning activities have positive effects in terms of triggering students to read the textbook before class in order to perform better in the activity.

Integrating the game-based CCIRS into a classroom promotes novice learners' learning performance

According to the qualitative data, the learners in the class were all engaged in the CCIRS course activities. Most of the students liked the ranking list in the system, and mentioned that the atmosphere was livelier in the classroom as a result. Besides, according to the questionnaire results, the findings are in accordance with a previous study which indicated that eagerness to have their names displayed on the scoreboard or ranking list is the main trigger that motivates students to become active learners (Wang, 2015). A previous study also indicated that sometimes noisy and disorganized learning happens when adopting game activities for teaching (Evans, 1979). However, even though we found the same situation that the students were moving around the classroom and the disorganized learning happened during the game-based CCIRS activity, however, the atmosphere in the class was full of joy.

One observation worth noting is the different learning behaviors of the various achievement learners during the course. The novice learners were willing to participate in the learning activities. They gathered around a common screen to discuss the learning content so as to get higher scores in the activity. CCIRS with competitive games fosters students' social learning and arouses discussion among peers. The instructor indicated that the novice learners were more confident in learning and sharing their thoughts through the game-based competitive activities, and confirmed that the novice learners showed great involvement in the CCIRS activity. Similar results were found in a previous study (Young & Wang, 2014) in which adopting game-based activities motivated less advanced students to engage in the learning activity. However, the findings are contrary to the results of Stapel and Koomen (2005) who indicated that competitive activities may be hurtful to or have negative influences on learners due to their lack of confidence.

Conclusion

In this study, the researcher attempted to answer the questions of whether the adoption of a cross-device interactive response system could improve students' learning motivation, and whether the integration of CCIRS formed a different classroom teaching and learning pedagogy. To answer these two research questions, the findings of the study demonstrated that the use of CCIRS with game-based competitive activities motivated the learners to acquire knowledge because they felt that they were playing a game instead of taking a test. The students reflected that learning with CCIRS is an entertaining experience, especially for novice and medium-achievement learners who, with the assistance of CCIRS, showed more engagement in the course and achieved significant improvement from the pre- to the post-tests. Van Eck (2006) indicated that "games are effective not because of what they are, but because of what they embody and what learners are doing as they play a game." The adoption of CCIRS integrated a gameplay element into the course interaction and thus improved learners' learning outcomes and increased their course engagement. CCIRS is an easy-to-use learning trigger that encourages students to participate in the activities and share their thoughts. Moreover, using CCIRS also arouses course discussion and involvement for the target learning subject and thus enhances students' social learning. For a long time, previous studies have indicated that the use of interactive response systems has some limitations such as the high cost of devices and setting up the environment. However, the use of this cloud-based IRS is quite intuitive and reduces the loading on the instructor of setting up the application environment. The idea of "bring your own device" (BYOD) could be implemented through the use of CCIRS. Students could use their own mobile phones or tablet PCs to access the activity, while those learners without appropriate devices could use classroom PCs. The instructors just have to log into the web-based interface and create the educational items following their experience of using computers.

In response to the third research question, the CCIRS system integrating the educational strategy, game-based competition, could be an aid used as reinforcement to support flipped classroom learning. The learners were engaged and activated to read and preview the educational contents prior to the course in order to correctly answer the questions raised by the teacher in the class. Besides, teachers could monitor each student's learning progress from the immediate accountability of responding to questions, and the system could be a tool to help instructors affirm that the learners have absorbed all of the important learning information. Furthermore, the integration of CCIRS might have a positive learning effect on forming flipped classrooms. The use of CCIRS with competitive gameplay in the course may be a suitable trigger for helping learners and instructors conduct flipped classroom applications. The CCIRS pedagogy supports novice learners to participate in learning, and the competitive activities trigger students to become active learners and enhance their social learning.

While the researcher noticed that adopting the game-based elements with CCIRS had the potential for promoting engagement in the classroom, it was also found that the use of the system might delay teaching progress when there is limited time to teach learning contents to students. Consequently, it is suggested that when designing and implementing CCIRS in school courses, the learning schedule of each course must be considered. What matters is whether the advanced tools and learning strategy can be used in interesting ways to promote ways of knowing not possible in existing teaching classrooms.

Limitations and future work

One of the limitations of this study was the small number of students in each subgroup. It is therefore suggested that future studies recruit more participants for confirming the research findings, especially when dividing the learners into subgroups for data analysis. It is also suggested that further studies could focus more on investigating students' performance and interaction differences with CCIRS. One final limitation of this study is that the target learners and subject of the study were teenagers and classical Chinese; thus, the results cannot be generalized to adult or younger learners or to other learning subjects. Other research issues could include whether students at various educational levels have different perceptions of using CCIRS and how to integrate different teaching pedagogies such as encouraging a learning loop from learners to leaders in the activity on CCIRS. Besides, it is also suggested to investigate whether there are differing learning effects on student's learning performance and behavior when adopting independent and collaborative learning work with CCIRS using sharable learning tools. Moreover, researchers could explore how CCIRS used together with the flipped classroom approach can foster learning and help students achieve higher order thinking performance, and whether the anonymous use of the system affects students' learning.

Acknowledgments

The authors would like to thank Ministry of Science and Technology in Taiwan (104-2511-S-032-008 and 105-2511-S-032 -002) for the support.

References

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.

Barber, M., & Njus, D. (2007). Clicker evolution: Seeking intelligent design. *CBE-Life Sciences Education, 6(1),* 1-8.

Boatright-Hortwitz, S. L. (2009). Useful pedagogies or financial hardships? Interactive response technology (clickers) in the large college classroom. *International Journal of Teaching and Learning in Higher Education, 21*(3), 295-298.

Brame, C. J. (2013). *Flipping the Classroom. Center for Teaching Vanderbilt University*. Retrieved from http://cft.vanderbilt.edu/teaching-guides/teachingactivities/flipping-the-classroom/

Caldwell, J. E. (2007). Clickers in the large classroom: Current research and best-practice tips. *CBE d Life Sciences Education, 6*(1), 9-20.

Carreira, J. M. (2006). Motivation for learning English as a Foreign Language in Japanese elementary schools. *JALT Journal, 28*(2), 135-157.

Chang, K. E., Lan, Y. J., Chang, C. M., & Sung, Y. T. (2010). Mobile-device-supported strategy for Chinese reading comprehension. *Innovations in Education and Teaching International, 47*(1), 69-84.

Chang, G. (2010). The Research of Grade 1-9 classic literature material. *Secondary Education, 61*(2), 94-121.

Chen, L. J. (2003). *The Design and implementation of technology-integrated instructional activities into high school Chinese curriculum—Take modern prose for example* (Unpublished master thesis). Tamkang University, Taiwan.

Chen, C.-H., & Chou, H.-W. (2007). Location-aware technology in Chinese language learning. In *Proceedings of the IADIS International Conference Mobile Learning* (pp. 189-193). Retrieved from https://www.researchgate.net/profile/Huey_Wen_Chou/publication/266338913_Location-aware_technology_in_Chinese_language_learning_IADIS/links/550240900cf231de076ddfc0/Location-aware-technology-in-Chinese-language-learning-IADIS.pdf

Chen, W., Worden, M. K., & Bradley, E. (2015). Flipping, engaging, and teaming, Oh My! Lessons Learned from a large scale curriculum reform at a US medical school. In *IEEE 15th International Conference on Advanced Learning Technologies (ICALT)* (pp. 488-492). doi:10.1109/ICALT.2015.68

Chen, Z. H., & Chen, S. Y. (2013). A Surrogate competition approach to enhancing game-based learning. *ACM Transactions on Computer-Human Interaction, 20*(6), 35. doi:10.1145/2524264

Chi L. C., & Chiou, G. F. (2015). Chinese teaching, reading comprehension, classic Chinese reading, reading process. *Journal of Chinese Language Teaching, 12*(2), 51-74.

Chiang, M. C. (2014). *Integrating multimedia into instruction for enhancing students' achievements in Chinese learning* (Unpublished master thesis). Mingdao University, Taiwan.

Chuang, Y. T. (2015). SSCLS: A Smartphone-Supported Collaborative Learning System. *Telematics and Informatics, 32*, 463-474.

Méndez, D., & Slisko, J. (2013). Software socrative and smartphones as tools for implementation of basic processes of active physics learning in classroom: An Initial feasibility study with prospective teachers. *European Journal of Physics Education, 4*(2), 17-24.

Coyne, R. (2003). Mindless repetition: Learning from computer games. *Design Studies, 24,* 199-212.

Davies, R. S., Dean, D. L., & Ball, N. (2013). Flipping the classroom and instructional technology integration in a college-level information systems spreadsheet course. *Education Technology Research Development*, *61*, 563-580.

De-Marcos, L., Garcia-Lopez, E., & Garcia-Cabot, A. (2016). On the effectiveness of game-like and social approaches in learning: Comparing educational gaming, gamification & social networking. *Computers & Education, 95,* 99-113.

Edge, D., Searle, E., Chiu, K., Zhao, J., & Landay, J. (2011). MicroMandarin: Mobile language learning in context. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 3169-3178). New York, NY: ACM.

Evans, D.-R. (1979). *Games and simulations in literacy training*. Tehran, Iran: Hulton.

Fardoun, H. M., & Alghazzawi, D. M. (2014). Cloud and interactivity technologies in flipped classrooms. In *Proceedings of the 2014 Workshop on Interaction Design in Educational Environments* (pp. 20). doi:10.1145/2643604.2643625

Gruenstein, A., McGraw, I., & Sutherland, A. (2009). A Self-transcribing speech corpus: Collecting continuous speech with an online educational game. In *Proceeding of the Speech and Language Technology in Education Workshop* (pp. 109-112). Retrieved from http://groups.csail.mit.edu/sls//publications/2009/SIGSLaTE09_Gruenstein.pdf

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A Six-thousand student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66*(1), 64-74.

Heaslip, G., Donovan, P., Cullen, J. G. (2013). Student response systems and learner engagement in large classes. *Active Learning in Higher Education, 15*(1), 11-24.

Hsieh, W.-J., Chiu, P.-S., Chen, T.-S., & Huang, Y-M. (2010). The Effect of situated mobile learning in Chinese rhetoric ability of elementary school students. In *Proceedings of the 6th IEEE International conference of Wireless, Mobile, and Ubiquitous Technologies in Education* (pp. 177-181). doi:10.1109/WMUTE.2010.36

Huang, C. W. (2013). *A Study of integrating rewarding mechanism into the classroom interactive system and its instructional applications* (Unpublished master thesis). National Tsing Hua University, Taiwan.

Huang, W. H. Y., & Soman, D. (2013). *A Practitioner's guide to gamification of education. Behavioural Economics in Action Report Series*. Toronto, Canada: Rotman School of Management, University of Toronto. Retrieved from http://inside.rotman.utoronto.ca/behaviouraleconomicsinaction/files/2013/09/GuideGamificationEducationDec2013.pdf

Kapp, K. M. (2012). *The Gamification of learning and instruction: Game-based methods and strategies for training and education*. San Francisco, CA: John C. Wiley& Sons.

Keough, S. M. (2012). Clickers in the classroom: A Review and a replication. *Journal of Management Education, 36*(6), 822-847.

Kiryakova, G., Angelova, N., & Yordanova, L. (2014). Gamification in education. In *Proceedings of 9th International Balkan Education and Science Conference*. Retrieved from http://dspace.uni-sz.bg/bitstream/123456789/12/1/293-Kiryakova.pdf

Lin, Y.-C., Liu, T.-C., & Chu, C.-C. (2011). Implementing clickers to assist learning in science lectures: The Clicker-assisted conceptual change model. *Australasian Journal of Educational Technology, 27*(6), 979-996.

Liu, Y., Owen, G. S., & Sunderraman, R. (2011). Computer games improve learning Chinese. In *Proceedings of the 2nd International Conference on Education and Management Technology* (pp. 260-265). Singapore: IACSIT Press.

Mayer, R. E., Stull, A., DeLeeuw, K., Almeroth, K., Almeroth, B., Bimber, B., Chun, D., Bulger, M., Campbell, J., Knight, A., & Zhang, H. (2009). Clickers in college classrooms: Fostering learning with questioning methods. *Contemporary Educational Psychology, 34*, 51-57.

Nichol, D. J., & Boyle, J. T. (2003). Peer instruction versus classwide discussion in large classes: A Comparison of two interaction methods in the wired classroom. *Stud. Higher Educ*ucation, *28*(4), 457-473.

Ministry of Education. (2013). 職業學校群科課程綱要之「總綱」[Syllabus for vocational school]. Retrieved from http://vs.tchcvs.tc.edu.tw/file/%E8%81%B7%E6%A0%A1%E7%BE%A4%E7%A7%91%E8%AA%B2%E7%A8%8B%E7%B6%B1%E8%A6%81%E7%B8%BD%E7%B6%B1%E6%89%8B%E5%86%8A_1030109%E6%9B%B4%E6%96%B0.pdf

Pond, S. B. (2010). Learner-centered use of student response systems improves performance in large class environments. *The Journal of Effective Teaching, 10*(2), 4-17.

Prensky, M. (2001). *Digital game-based learning*. New York, NY: McGraw-Hill.

Pardo, A., Pérez-Sanagustín, M., Parada G., Hugo A., & Leony, D. (2012). Flip with care. In *Proceedings of SoLAR Southern Flare conference*. Sydney, Australia: Univeristy of Technology Sydney.

Sams, A., & Bergmann, J. (2013). Flip your students' learning. *Educational Leadership, 70*(6), 16–20.

Stowell, J. R. (2014). Use of clickers vs mobile devices for classroom polling. *Computer & education, 82*, 329-334

Stapel, D. A., & Koomen, W. (2005). Competition, cooperation, and the effects of others on me. *Journal of Personality and Social Psychology, 88*, 1029-1038.

Tan, L. J., Goh, H.-L. D., Ang, P. R., & Huan, S. V. (2013). Participatory evaluation of an educational game for social skills acquisition. *Computers & Education, 64*, 70-80.

Tam, V., & Cheung, R. L. F (2012). An Extendible and ubiquitious e-learning software for foreigners. In *Proceedings of the 12th IEEE International Conference on Advanced Learning* Technologies (pp. 46-48). doi:10.1109/ICALT.2012.65

Tsai, F.-H., Yu, K.-C., & Hsiao, H.-S. (2012). Exploring the factors influencing learning effectiveness in digital game-based learning. *Educational Technology & Society, 15*(3), 240-250.

Van Eck, R. (2006). Digital game-based learning: It's not just the digital natives who are restless. *Educause Review*, *41*, 16-30.

Wang, A. I. (2015). The Wear out effect of a game-based student response system. *Computer & Education, 82*, 217-227.

Wei, Y. J. (2013). *Implementing a game-based learning system with a competitive mechanism to enhance students' learning motivation* (Unpublished master thesis). National TsingHua University, Taiwan.

Young, S.-S.-C., & Wang, Y.-H. (2014). The Game embedded call system to facilitate English vocabulary acquisition and pronunciation. *Educational Technology & Society*, *17*(3), 239-251.