A Study of Computer-aided Instruction and Competition Strategy toward Young Learners

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ABSTRACT
A purposive sampling was conducted with 109 students from Anding elementary school, Taiwan. First, we found perceived ease of learning, enjoyment, self-efficacy, social interaction and learning attitude have significant differences between integrated teaching approach and Spoon-feeding instruction in this study. Second, the research framework has been proven perceived ease of learning and enjoyment positively influence on self-efficacy and learning attitude. Furthermore, we have verified self-efficacy positively influence on social interaction. Moreover, social interaction positively influences on learning attitude. Two contributions are found in this study. First, we adopted the concept of open innovation to design digital orchid game and integrated teaching approach. Second, we verified the connections of the research model with great model fit.
Keywords: perceived ease of learning; enjoyment; self-efficacy; social interaction; learning attitude

INTRODUCTION

Interactive teaching instructions incorporating with technological supports may shed a light for students in Taiwan to increase learning attitude as well as gain practical competencies for the competitive twenty-first centuries. Enthusiastic and dedicated teachers have close observation on Taiwan education and pointed out the two major current problems of Taiwan education. First, Spoon-feeding instruction (SFI), intensive test measurements, and punishment systems may have entitled Taiwanese students' excellent performance on the pen-write test within a limited time in the past decades. Thus, most lecturers enjoy the past glories and enjoy adopting SFI as the main teaching instruction. However, it also has negative impacts on students' learning attitude and independent thinking competence in the long run. Second, young students of Taiwan borne in cyber age are raised and accompanied by tablets; therefore, on-line games and applications serve as key elements in their everyday life. Surrounding by the digital environment, those young learners use to receive information via visual and sound effects. Comparing to the interactive lecturing, tradition teaching approach such as SFI looks awkward and it makes those young students show less interested in classroom learning. Owing to the two critical reasons mentioned above, education in Taiwan gradually have lost their edge in the world. Fortunately, proactive teachers perceive the young students borne in cyber age fond of playing digital games. The attributes of those digital games comprise of ease of learning and enjoyment, which support young learners to gain self-efficacy, to participate social activities, and to improve learning attitudes. Therefore, we intend to design interactive and interesting curricula, which include attributes of computer-aided instruction and competition strategy to replace spoon-feeding instruction, to improve students' learning attitude.

The International Telecommunication Union (2012) indicated that technological learning plays as an important factor in education reform in some Asian countries. The development of telecommunication technologies has changed the directions of government education policies, especially in North East Asia. For example, Korea focuses on self-directed mobile learning projects (Lee, 2012). Japan is aimed at context-aware language learning projects (Ogata et al., 2010), and Taiwan is engaged in a national e-learning project (Huang & Tsai, 2011). The development and application of technology-enhanced learning using educational computer games have increased rapidly in the past decade (Hwang and Wu, 2012). Prior studies have emphasized the importance of technology in improving student attitudes toward learning (Davis, 1989) and performance (Brunner & Tally, 1999). Other study depicted that support from technologies will enhance learner participation in educational settings (McLoughlin & Lee, 2010). Owing to the mentioned above, the concept computer-aided instruction is considered the crucial element to inspire apprentices' learning attitudes. In order to have better teaching performance, we invite professors in orchid domain and engineers from Industrial Technology Research Institute (ITRI) to design an interactive orchid game as teaching material (Chesbrough, 2003). Besides, we also incorporate team mind mapping and a competition strategy in the digital orchid game to enhance self-efficacy via team brainstorming and to improve interpersonal skills via intensive social interaction. Finally, we expect the combination of teaching approaches might attract learner attention as well as provide a contribution to improvements in learning attitude. The further information of research theories and framework of Technology Acceptance Model will be discussed in the

following pages.

LITERATURE REVIEW

Theories and approaches

Computer-assisted instruction (CAI), which combines of text, graphics, sound and video, is an interactive instructional technique to facilitate and improve instruction. Anohina (2005) indicated that Computer-assisted instruction (CAI) acts as a supporting reaching approach to developing students' knowledge via activities. The advantages of CAI provide students one-to-one interaction, self-pacing, and self-directed learning. Prior studies have proven that support from computer programs helps students acquire both language and reading skills (Elena, Krueger, & Markman, 2004) better than traditional teaching (Lepper & Gutner, 1989). Therefore, interactive curriculum design such as computer-aided instruction facilitates students to gain attention and motivation through intensive interactions. Mind Mapping might be an efficient and feasible approach to support students to gain competence of logical reasoning competence in interactive curriculum. Biktimirov and Nilson (2006) stated that mind mapping, which involves the use of logical and systematic thought to express the imagination. Students gain knowledge and improve learning attitudes through transform individual thoughts into a diagram to communicate with the real world. For enhancing learning attitude, adding the element of competitive strategy into the new curriculum might be an excellent option to make students pay great attention in learning. Deutsch (1973) argued that competition strategy, which not only efficiently affect knowledge acquisition and transformation (Pe-Than, Goh, & Lee, 2014), but also enhance learning performance as well as motivation (Burguillo, 2010) is the act of attempting to gain achievements. The approaches of team brainstorming and competition may enhance learning attitudes but also incur quarrels and conflicts as well. In order to solve those challenges, we also adopt social learning theory, which puts great efforts on observing continuous reciprocal interaction among cognitive, behavioral, and environmental influences to explore the connections of the behaviors, attitudes, and emotional reactions of others (Bandura, 1977). Each mentioned teaching method had been proven on the improvement of learning attitude. Thus, this research intends to integrate the mentioned teaching approaches, named ITA, to develop a new curriculum and we expect the innovative curriculum does improve students' learning attitudes effectively and efficiently. In the following pages, we plan to discuss the elements of Technology Acceptance Model.

Modified Technology Acceptance Model (TAM)

Davis (1989) proved that perceived ease of learning and enjoyment both improve students' performance and learning attitude. Another study explained that perceived usefulness and ease of use have a positive influence on performance, attitude, and intention in the mobile technology context (Lu, Yao, & Yu, 2005). Additionally, enjoyment is regarded as an intrinsic factor that has a positive influence on attitude (Davis, Bagozzi, & Warshaw, 1992; Nysveen, Pedersen, & Thorbjørnsen, 2005). The reviews above indicate that perceived ease of learning and enjoyment not only indirectly increase learners' self-efficacy via obtaining excellent performance, but also improve their learning attitudes as well.

Furthermore, Bandura (1982) indicated that efficacy belief is the driving force that triggers motivation and influences how we think, feel, and associate with others. Self-efficacy has also been defined as when individuals have the ability to cooperate with partners for the purpose of completing appointed tasks (Bandura & Ozer, 1990). Hence, it has been verified that when students have greater self-efficacy, they will be more involved in social interaction with their peers to complete assigned homework tasks (Compeau & Higgins, 1995). Thus, the reviews above-mentioned show two connections, which are self-efficacy to social interaction and self-efficacy to learning attitude.

Moreover, social affordance is defined as when the curriculum design requires social interaction (Kreijins, Kirschner, & Jochems, 2002). Other studies indicate that mobile devices not only provide students with more opportunities to participate in learning activities (Roger et al., 2005), but also increase social interactions (Markett, Sanchez, Weber, & Tangney, 2005) and collaboration in the classroom (Lai & Wu, 2006; Schwabe & Goth, 2005). Tseng (2001) suggested that social interaction and self-recognition are motivations of users related to engagement in playing games (Tseng, 2001). Owing to the reviews, we may reason that social interaction have relationship with learning attitude.

To improve students' learning attitudes, we engage in new curriculum design in two directions. On one hand, we might presume that computer-aided instruction will improve students' learning attitudes via an ease of learning environment and an interactive interface. On the other hand, mind mapping incorporating competitive strategy will facilitate students to engage in intensive social interaction and collaboration as well as toward polishing their interpersonal skills and increasing self-efficacy. We expect that the curricula will make young learners experience

greater degrees of self-efficacy and social interaction as well as improvements in learning attitude. Consequently, we consider that designing an entertaining, interactive digital teaching curriculum might be the first stage to arouse students' learning attitude. The research questions addressed in this study include the following:
H1: The more perceived ease of learning that students feel via the integrated teaching approach, the greater self-efficacy that they will have.
H2: The more perceived ease of learning that students feel via the integrated teaching approach, the improvements of learning attitude that they will be.
H3: The more enjoyable the students feel via the integrated teaching approach, the greater self-efficacy that they will possess.
H4: The more enjoyable the students feel via the integrated teaching approach, the improvements of learning attitude that they will be.
H5: The greater self-efficacy that the students possess via the integrated teaching approach, the more social interactions through teamwork that they will engage in.
H6: The higher self-efficacy that students gain via the integrated teaching approach, the greater improvement of learning attitude it will be.
H7: The more social interactions that young students benefit from the integrated teaching approach, the greater improvement of learning attitude it will be.

METHODOLOGY

Case introduction

Anding Elementary School is located in agricultural county in southern Taiwan, Tainan. Like many present societies, children are unavoidable raised by tablets and the method of nurture without careful instruction may jeopardize young students' learning skills. Owing to the above mentioned, the principal and the teachers of Anding Elementary School considered improving students' learning attitude through integrated instruction. With a close observation of young students' attitude toward digital games, they found that learners showed great interest in interactive games. Most digital games are designed for younger users and have become a popular game industry in the 21th century. However, only a few games were designed for the educational domain especially for primary school students. Therefore, how to improve learning attitudes has become an important issue for teachers. Prior studies have indicated the importance of digital games in the younger generation.

For me, I am a researcher in education domain and a long-term observer of Anding Elementary School in teaching techniques. Teacher Chen, program initiator, invites me to participating the program of computer-aided instruction. We plan to select science classes as an experiment and the classes provide students required knowledge of growing plants. In order to make students enjoy in learning, we therefore designed an integrated instruction method including a digital orchid game, team mind mapping, and competition strategy. In conclusion, we anticipated that the orchid game will not only make young participants feel at ease in the digital learning world, but also will experience improvement in their degree of self-efficacy and social interaction. Finally, we expected that the new teaching approach would improve learning attitude of these students.

Curriculum design & teaching processes.

The goal of this enjoyable and ease of learning curriculum, exploring the cycle of orchid world, intends to train students to improve their self-efficacy, social skills, and learning attitude. To achieve the curriculum goal, five curriculum design processes are required. In the first step, we have to know young learners' learning attitudes toward computer games and the top five popular types of computer games played by young students. Recognition certain types of flower and understanding their life cycles through team discussions are the goals of step 2. In the third step, the orchid game was served as a teaching aid in classroom teaching and teammates must be familiar with the interface. Then, the knowledge of growing orchids in different phases, which include seed production, germination, seed formation, seed maturation, and flowering shown on figure 1. In the fourth step, through team information searching and intensive social interactions, students gain five stages of important knowledge of growing orchids such as seed production, germination, seed formation, seed maturation, and flowering. Additionally, they also attain the required knowledge of growing orchids during different phases like illumination, day temperature, night temperature, humidity, fertilizer, and watering. In the fifth step, the participating students have to key-in the proper answers of illumination, temperature, humidity, fertilizer, and watering in order to grow excellent orchids. This integrated instructional approach encourages learners to brainstorm and develop the proper ways to grow orchids through intensive social interaction in order to improve their interpersonal skills. In addition, the students gained heterogeneous competencies including information searching, oral expressions, and writing skills while they completed the assignment. Finally, the processes of this innovative curriculum improve not only students' self-efficacy and interpersonal skills, but also their learning attitudes. The detailed information was shown in table 1.

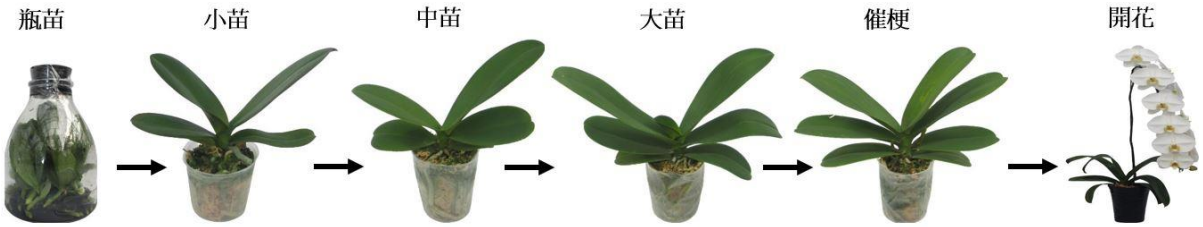

Figure 1. The processes of growing orchids

Table 1. Curriculum &teaching design

Steps	Curriculum goals/ teaching approaches
Step1	Influences of computer games on young learners/ Related information search Young learners' learning attitudes toward computer games Top five popular types of computer games played by young students
Step 2	Flower articles in the textbook/ Knowledge of flowers Recognition of flower types Understanding the life cycle of plants
Step 3	External resources (ITRI)/ Orchid game Orchid game serving as computer aids Knowledge of growing orchids in different phases Knowledge of seed production, germination, seed formation, seed maturation, and flowering
Step 4	Knowledge of orchid grown in different phases / Team information searching Searching the information of growing orchids in different phases in teams Requirements such as illumination, fertilizer, and watering for each phase in teams 3. Intensive social interaction through team knowledge sharing and discussions
Step 5	Orchid game competition/ Orchid knowledge application Key-in the proper answers of illumination, temperature, humidity, fertilizer, and watering

Game design

The concept for the digital orchid game comprises growing stages and conditions. The growing stages consist of five stages: seed production, germination, seed formation, seed maturation, and flowering. Moreover, six crucial requirements such as illumination, day temperature, night temperature, humidity, fertilizer, and watering must be considered in different cultivation periods. Providing orchids with the proper growing conditions at different growth stages poses a great challenge to students. Therefore, the orchid game was designed by stages, ranging from an easy level to a difficult one. Finally, we expect that the participants will experience enhanced self-efficacy and improved interpersonal skills through intensive social interaction and in turn will also develop improved attitudes toward learning. Figure 2 indicates the interfaces of each growing stage in the digital orchid game.

Figure 2. The interfaces of each growing stage in the digital orchid game

Procedure and samples

We plan to run both the research model and experimental design are examined in this study. In terms of the research model, we intend to investigate the connections in the research model, including the influences of perceived ease of learning and enjoyment on students' self-efficacy, social interaction, and learning attitude. In terms of the experimental design, we intend to examine whether the computer-aid instruction and spoon-feeding instruction exist differences; thus, we adopted t-test in this research. The examining processes are divided into two stages. In

the first stage, we asked the participants to fill out questionnaires without any instructions. In the second stage, the participating students experienced the integrated teaching approach. Then, the participants had to fill out the same questionnaires again. In this study, we also run t-test to examine whether perceived ease of learning, perceived enjoyment, self-efficacy, social interaction and learning attitude exist differences.

Our sampling of research model focused on fourth, fifth and sixth grade students in Anding primary school, Tainan. Three measurements were adopted in different periods to avoid common method variance. First, we hid reverse questions in the questionnaires. Second, two stages of filling out questionnaires were designed in the middle of semester and in the end of semester respectively. Finally, verifying discriminant validity exists in each construct. We only had 45 responses for polite study for examining consistency and developing corrected semantic and syntax. The survey took place from March 4th to 22th in 2019. With 109 questionnaires were filled out in class and 109 valid responses, 100 percentage of response rate. Figure 3 is the experimental procedure used in this study.

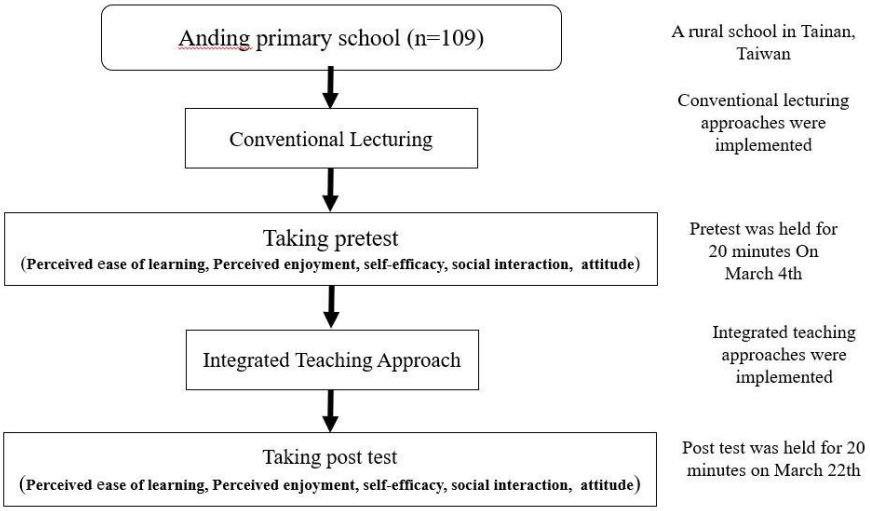

Figure 3. Experimental procedure

Operational definition

With regard to the purpose of facilitating perceived ease of learning and enjoyment, self-efficacy (Bandura, 1982), social interaction (V.D. Hoogen, Ijsselsteijn, & Kort), and attitude (Davis et al., 1992), a set of measurements associated with the learning acceptance model, were borrowed from the concept of TAM (Davis et al., 1992) for which the items were modified for the purposes of this study. The rubrics aimed at evaluating perceived ease of learning, enjoyment, self-efficacy, social interaction, and learning attitude (see table 2) were provided to both groups to help them review self-efficacy, social interaction, and learning attitude while learning. Pictures of lecturing students are provided in Figure 4.

Table2. Operational Definitions of Constructs

Operational Definitions
Perceived ease of learning: Sources: Davis (1989), seven-point Likert scale
POE1. The game is easy to learn. POE 2. The orchid game has an easy to use learning platform. POE 3. Users easily and vividly experience growing orchids in this game. POE 4. The interface of orchid game is user friendly. POE 5. The interactive model of the orchid game is easy to understand. POE 6. The learned knowledge from the orchid game can be easily transferred into growing real orchids.
Social Interaction: Sources: (V. D. Hoogen, Ijsselsteijn, & Kort, 2009), seven-point Likert scale
SI1. The orchid game is a multiplayer game. SI2. Discussing growing orchids with others polishes our skills while playing the orchid game. SI3. The orchid game can become a conversation topic with others. SI4. I can invite other people to play the orchid game with me. SI5. I can share orchid game information with others. SI6. I can exchange my experiences with growing orchids learned while playing the game with others.
Enjoyment Sources: Davis (1989), seven-point Likert scale

EJY1. It is interesting that the orchid game helps users experience the processes of growing virtual orchids. EJY2. It is interesting to experience growing orchids. EJY3. Controlling orchid growing conditions is interesting. EJY4. Playing the orchid game can help us enjoy learning to take good care of orchids. EJY5. Playing games and acquiring knowledge satisfies me. EJY6. I enjoy the process of growing orchids in virtual reality.
Self-efficacy: Sources: (Bandura, 1982), seven-point Likert scale
SE1. The orchid game helps us understand the orchid growth process. SE 2. The orchid game helps us learn the skills required to grow orchids. SE 3. The orchid game provides us with memory training. SE 4. Playing the orchid game is the first step of learning the use of a computer. SE 5. Playing the orchid game helps us kill time. SE 6. Playing the orchid game can be an interface for interactions among people. SE 7. The orchid game is a tool by which to acquire new knowledge.
Attitude Sources: (Davis et al., 1992), seven-point Likert scale
ATT1. I have intentions to play orchid game. ATT2. I will recommend others to play orchid game. ATT3. I will play the orchid game to learn how to grow orchids. ATT4. Before growing a real orchid, I will start to acquire knowledge by playing the orchid game. ATT5. I will grow orchids using the knowledge I got from the orchid game. ATT6. I will continue to be concerned about my progress in the orchid game.

Lecturing

Team discussion

Playing the orchid game

Figure 4. Content of orchid game

ANALYSIS AND RESULTS

Validity and Reliability

Some criteria for validity and reliability are given as follows: KMO >0.5, communality >0.5, eigenvalue >1, factor loading >0.6, Cronbach's alpha >0.7 and item-total correlation >0.6. The factor loadings for the four items of the attitude construct meeting the requirements were 0.86, 0.87, 0.88, 0.84, 0.80, and 0.86 (α=0.92). Independent variables: The five factor loading items for the perceived ease of learning construct were 0.78, 0.82, 0.85, 0.81, 0.86, and 0.82 (α=0.90). Six items for the enjoyment construct met the requirements, with factor loadings of 0.86, 0.88, 0.91, 0.90, 0.89, and 0.84 (α=0.94). Then, six modified items were used to measure social interaction, and all items with factor loadings of 0.91, 0.86, 0.90, 0.90, 0.90, and 0.78 (α=0.94) were retained. Seven items in the self-efficacy construct were modified, of which only three items SE1, SE2, and SE7 with factor loadings 0.84, 0.77, and 0.74 (α=0.86) were kept, as shown in Table 3. Then, the model fit based on the confirmatory factor analysis in this study was good, for which the figures were CMIN/DF=2.62, NFI=0.95, RFI=0.93, IFI=0.96, TLI=0.96, CFI=0.96, and RMSEA=0.07.

The convergent validity of a construct can be evaluated using two criteria: composite reliability and average variance extracted, which are required to be higher than 0.6 and 0.5, respectively (Fornell, 1981). The values for composite reliability in this study were 0.92, 0.95, 0.95, 0.82, and 0.94, and the AVE values were 0.67, 0.77, 0.76, 0.61, and 0.72. Both were higher than 0.6 and 0.5 respectively, shown on Table 2. Hair argued that the square root of the AVE should be at least 75% higher than the correlation coefficients among the constructs (Hair, Anderson, Tatham, & Black, 1998). The diagonal values were 0.82, 0.88, 0.87, 0.78, and 0.85, which were all higher than the correlation coefficients, as shown on Table 4; thus, the constructs showed good discriminant validity.

Table 3. Validity and Reliability

Construct	Items	Factor Loading	α	CR	AVE
Ease of Learning	POE1. The game is easy to learn.	0.78	0.90	0.92	0.67
	POE2. The orchid game has an easy to use learning platform.	0.82			
	POE3. Users easily experience growing orchids in this game.	0.85			
	POE4. The orchid game interface of is user friendly.	0.81			
	POE5. The interactive model for the orchid game is easy to understand.	0.86			
	POE6. The learned knowledge can be applied to growing real orchids.	0.82			
Enjoyment	EJY1. Experience the processes of growing virtual orchid.	0.86	0.94	0.95	0.77
	EJY2. It is interesting to experience growing orchids.	0.88			
	EJY3. Controlling orchid growing conditions is interesting.	0.91			
	EJY4. Playing the orchid game helps us take good care of orchids.	0.90			
	EJY5. Playing games and acquiring knowledge is satisfying.	0.89			
	EJY6. I enjoy the process of growing orchids in virtual reality.	0.84			
Social Interaction	SI 1. The orchid game is a multiplayer game.	0.91	0.94	0.95	0.76
	SI 2.Discussing orchid knowledge with others polishes social skills.	0.86			
	SI 3. The orchid game can be a conversation topic with others.	0.90			
	SI 4. I can invite other people to play the orchid game with me.	0.90			
	SI 5. I can share orchid game information with others.	0.90			
	SI 6. I can exchange my experiences with growing orchids.	0.78			
Self-efficacy	SE 1. The orchid game helps us understand the growing process.	0.84	0.86	0.82	0.61
	SE 2. The orchid game helps us learn the skills required to grow orchids.	0.77			
	SE 7. The orchid game is a tool by which to acquire new knowledge.	0.74			
Attitude	ATT1. I have intentions to play the orchid game.	0.86	0.92	0.94	0.72
	ATT2. I will recommend others to play the orchid game.	0.87			
	ATT3. I will play the orchid game to learn how to grow orchids.	0.88			
	ATT4. Before growing a real orchid, I will start to acquire knowledge by playing the orchid game.	0.84			
	ATT5. I will grow orchids using the knowledge I got from the orchid game.	0.80			
	ATT6. I will continue to be concerned about my progress in the orchid game.	0.86			

Table 4. Discriminant Validity

	Ease of learning	Enjoyment	Social Interaction	Self-efficacy	Attitude
Ease of learning	(0.82)				
Enjoyment	0.74***	(0.88)			
Social Interaction	0.72***	0.72***	(0.87)		

Self-efficacy	0.58***	0.71***	0.58***	(0.78)	
Attitude	0.73***	0.79***	0.84***	0.69***	(0.85)

Experimental results

Analysis of perceived ease of learning

Table 5 shows the descriptive statistics and independent-sample t test results for perceived ease of learning. The mean value and standard deviation in the post-questionnaire were 5.25 and 1.02 for the integrated teaching approach and were 3.34 and 0.82 with spoon-feeding instruction, respectively. Based on the independent-sample t test results, significant effects are found in perceived ease of learning ($t=17.56$, $p<0.001$). This suggests that the integrated teaching instructing young students how to play orchid game could make them feel easier than spoon-feeding instruction.

Table 5. Descriptive data and t-test in perceived ease of learning of the two groups

Experiment design	N	Mean	SD	Std. error	t
Spoon-feeding instruction	109	3.34	0.82	0.068	17.56***
Integrated teaching approach	109	5.25	1.02	0.085	

Analysis of perceived enjoyment

Table 6 shows the descriptive statistics and Independent-Sample T Test result of perceived enjoyment. Both of the mean value and standard deviations in post-questionnaire were 5.40 and 0.99 with the integrated teaching approach, and 3.01 and 0.41 with spoon-feeding instruction. From the Independent-Sample T Test result, significant effects are found in perceived enjoyment ($t=26.89$, $p<0.001$). This suggests that the integrated teaching instructing young students how to play orchid game could make them feel more enjoyable than spoon-feeding instruction.

Table 6. Descriptive data and t-test in enjoyment of the two groups

Experiment design	N	Mean	SD	Std. error	t
Spoon-feeding instruction	109	3.01	0.41	0.081	26.89***
Integrated teaching approach	109	5.40	0.99	0.034	

Analysis of self-efficacy

Table 7 shows the descriptive statistics and Independent-Sample T Test result of self-efficacy. Both of the mean value and standard deviations in post-questionnaire were 5.76 and 0.95 with the integrated teaching approach, and 2.95 and 0.68 with spoon-feeding instruction. From the Independent-Sample T Test result, significant effects are found in self-efficacy ($t=29.60$, $p<0.001$). This suggests that the integrated teaching instructing young students how to play orchid game could make them increase more self-efficacy than spoon-feeding instruction.

Table 7. Descriptive data and t-test in self-efficacy of the two groups

Experiment design	N	Mean	SD	Std. error	t
Spoon-feeding instruction	109	2.95	0.68	0.056	29.60***
Integrated teaching approach	109	5.76	0.95	0. 079	

Analysis of social interaction

Table 8 shows the descriptive statistics and Independent-Sample T Test result of social interaction. Both of the mean value and standard deviations in post-questionnaire were 5.00 and 1.14 with the integrated teaching approach, and 3.21 and 0.65 with spoon-feeding instruction. From the Independent-Sample T Test result, significant effects are found in social interaction ($t=16.25$, $p<0.001$). This suggests that instructing young students how to play orchid game could make them have the same topic of growing orchid. Thus, those students have more discussions and social interactions with classmates than spoon-feeding instruction.

Table 8. Descriptive data and t-test in social interaction of the two groups

Experiment design	N	Mean	SD	Std. error	t
Spoon-feeding instruction	109	3.21	0.65	0.054	16.25***
Integrated teaching approach	109	5.00	1.14	0. 094	

Analysis of attitude

Table 9 shows the descriptive statistics and Independent-Sample T Test result of attitude. Both of the mean value

and standard deviations in post-questionnaire were 5.06 and 1.15 with the integrated teaching approach, and 3.29 and 0.73 with spoon-feeding instruction. From the Independent-Sample T Test result, significant effects are found in attitude (t=15.56, p<0.001). This suggests that the integrated teaching instructing young students how to play orchid game could make them have positive learning attitude on orchid game than spoon-feeding instruction.

Table 9. Descriptive data and t-test in attitude of the two groups

Experiment design	N	Mean	SD	Std. error	t
Spoon-feeding instruction	109	3.29	0.73	0.060	15.56***
Integrated teaching approach	109	5.06	1.15	0. 095	

Results of the Research Model

The VIF values were below 10 (Neter, Kutner, Nachtsheim, & W., 1996) which verified no issue of multi-collinearity in this research model. In addition, those figures showed good model fit of Structural Equation Models were as following: CMIN/DF=2.72, NFI=0.81, IFI=0.88, TLI=0.86, CFI=0.88. The results of the regressions were illustrated as follow: Firstly, perceived ease of learning had significant influence on self-efficacy (β=0.25，p＜0.01) and attitude (β=0.19，p＜0.01) so hypothesis 1 and 2 were supported. Secondly, enjoyment had positive influence on Self-efficacy (β=0.83，p ＜0.001 and attitude (β=0.41，p＜0.01); therefore, hypothesis 3 and 4 were supported. Thirdly, Self-efficacy had positive influence on Social Interaction (β=0.75，p ＜ 0.001); hence, hypothesis 5 was supported. Furthermore, we also found out that social interaction had positive influence on Attitude (β=0.57，p ＜ 0.001); therefore, H7 was supported. However, it showed no significant influence between self-efficacy and attitude (β=0.03，p > 0.05); thus, H6 was not supported. Finally, the results of research model were shown on figure 5 and table 10 respectively.

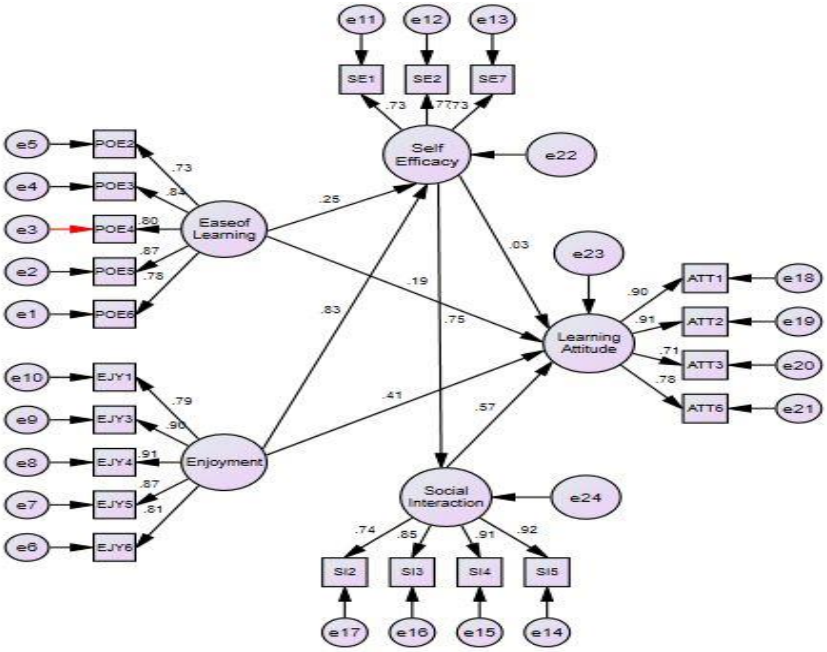

Figure 5. The results of framework

Table 10. Results of Hypothesis

	Hypothesis	Results
H1	The more perceived ease of learning that students feel via the integrated teaching approach, the greater self-efficacy that they will have.	Supported
H2	The more perceived ease of learning that students feel via the integrated teaching approach, the improvements of learning attitude that they will be.	Supported
H3	The more enjoyable the students feel via the integrated teaching approach, the greater self-efficacy that they will possess.	Supported
H4	The more enjoyable the students feel via the integrated teaching approach, the improvements of learning attitude that they will be.	Supported
H5	The greater self-efficacy that the students possess via the integrated teaching approach, the more social interactions through teamwork that they will engage in.	Supported

H6	The higher self-efficacy that students gain via the integrated teaching approach, the greater improvement of learning attitude it will be.	Not Supported
H7	The more social interactions that young students benefit from the integrated teaching approach, the greater improvement of learning attitude it will be.	Supported

CONCLUSIONS

We introduce open innovation which incorporate experts from ITRI, National Cheng Kung University (NCKU) and primary school. Having further discussions, the contents of orchid game with those heterogeneous specialists. A cycle of growing orchid becomes the theme of this digital game. Each participating member put great efforts on their domains. The engineers from ITRI engage in orchid game design and the professors from NCKU supported the primary school teachers to work on curriculum design. Figure 6 indicates the open concept of interdisciplinary team in this study.

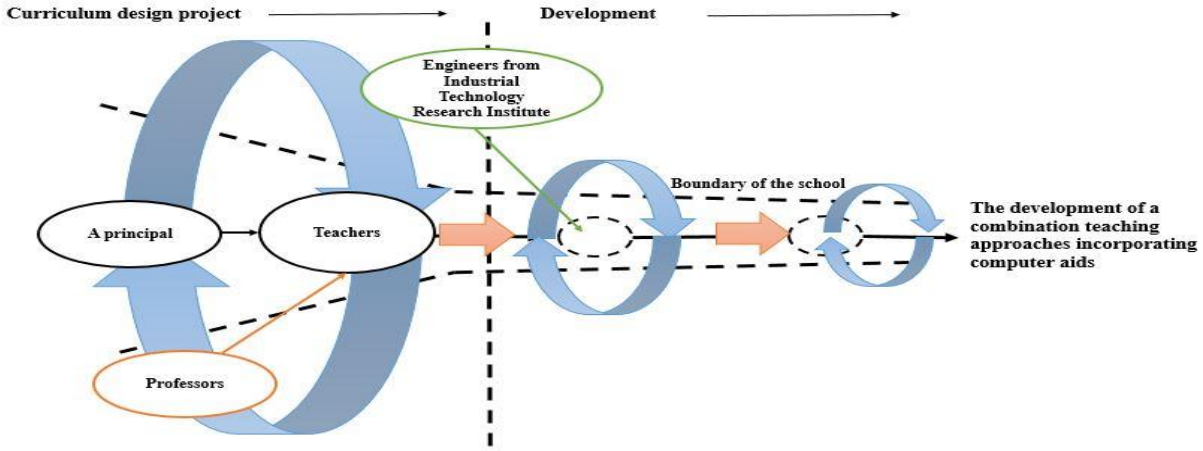

Figure 6. The processes of the open interdisciplinary team

This research aims at exploring how perceived ease of learning, enjoyment affect self-efficacy, social interaction and learning attitude in the interactive orchid digital games. Regressions and T-test are both implemented in this study. In the regression aspect, the results firstly indicate that perceived ease of learning and enjoyment have positive connections with self-efficacy and learning attitude. Secondly, those learners gain great self-efficacy via sharing orchid knowledge with teammates. It proves that self-efficacy has positive connections with social interaction. The learning approach benefits students in two sects, cycle of growing orchids acquisition and interpersonal skill improvement. Finally, the results also reveal intensive social interaction might affect those participating pupils' learning attitudes. In conclusions, these findings have verified Technology Acceptance Model (Davis et al., 1992) is helpful while adopting interactive digital games as teaching aids in classroom. In the t-test aspect, the results indicate that perceived ease of learning, enjoyment, self-efficacy, social interaction and learning attitude have significant differences between the integrated teaching approach (ITA) and spoon-feeding instruction (SFI) in this study. The students receiving SFI have less interested in curriculum. However, the students receiving ITA show great interested in the orchid knowledge acquisition.

Via close observations, the results show that the integrated teaching approach has positive influences on students in the five aspects. In the aspect of perceived ease of learning: Those participants consider that the orchid game is easy to learning and the interfaces of the platform is friendly. Besides, the game provides users vivid experiences of growing orchids. In the aspect of perceived enjoyment: The students feel that understanding the key knowledge growing orchids is interesting and seeing the orchids taken good care in different stages on computer screen makes those students satisfied. In the aspect of self-efficacy: The orchid game helps students learn the required knowledge to grow orchids in different stages and the learned knowledge can be easily transferred into growing real orchids. In the aspect of social interaction: The orchid game can become a conversation topic among classmates and the participating students can also share information of growing orchids with others. After gaining a systematic knowledge of growing orchids, students can easily complete the challenges of growing orchid. Thus, the intensive activities of orchid information sharing make students immerge in positive social interaction. In the aspect of learning attitude: Since the students have learned knowledge of growing orchid via digital games, they constantly ask teachers to provide other digital education materials for classroom learning; besides, the students also promote the advantages of digital games brought to them. The moves show that computer-aided instruction may have great possibility to change those participants' learning attitudes.

Four findings are in this study. First, game attributes of ease of use and enjoyable orchid game open a door for

students with great learning attitude to access orchid knowledge. Second, competition strategy and game attributes make students enthusiast to search the orchid information on website and discuss with team members for developing best answers. Third, via group mind mapping instruction to gain orchid knowledge such as humidity, temperature and nutrient soil, the hardworking on orchid knowledge acquisition make them gain great achievement. The achievements include self-efficacy enhancement, interpersonal skill polish, and learning attitude improvement during teamwork information searching processes. Fourth, the integrated teaching approach also facilitates those learners to increase learning students' attitude through intensive social interaction. Interesting and interactive instruction makes students not only gain practical competencies, but also experience the processes of knowledge management including knowledge searching, sharing, acquisition, accumulation, integration, and application about orchid knowledge. Through participating these curricula, students gain competencies of critical thinking & problem solving, cooperation, adaptation, information search & analysis, oral expression & writing skills and imagination. The detailed information is shown on figure 7 and table 11. The findings may suggest that incorporating ease of learning and enjoyable interactive contents will enhance students' self-efficacy, polish social skills and increase learning attitude.

Two contributions are found in this study. First, we adopted the concept of open innovation to design digital orchid game and integrated teaching approach. Second, we verified the connections of the research model with great model fit. In conclusions, this study has found that participating students pay great learning attitudes in classroom learning. It should be noted as a small-scale investigation on integrated teaching approach adoption and we will feel pleased to see the new teaching approach to implement in junior high and senior high school in Taiwan.

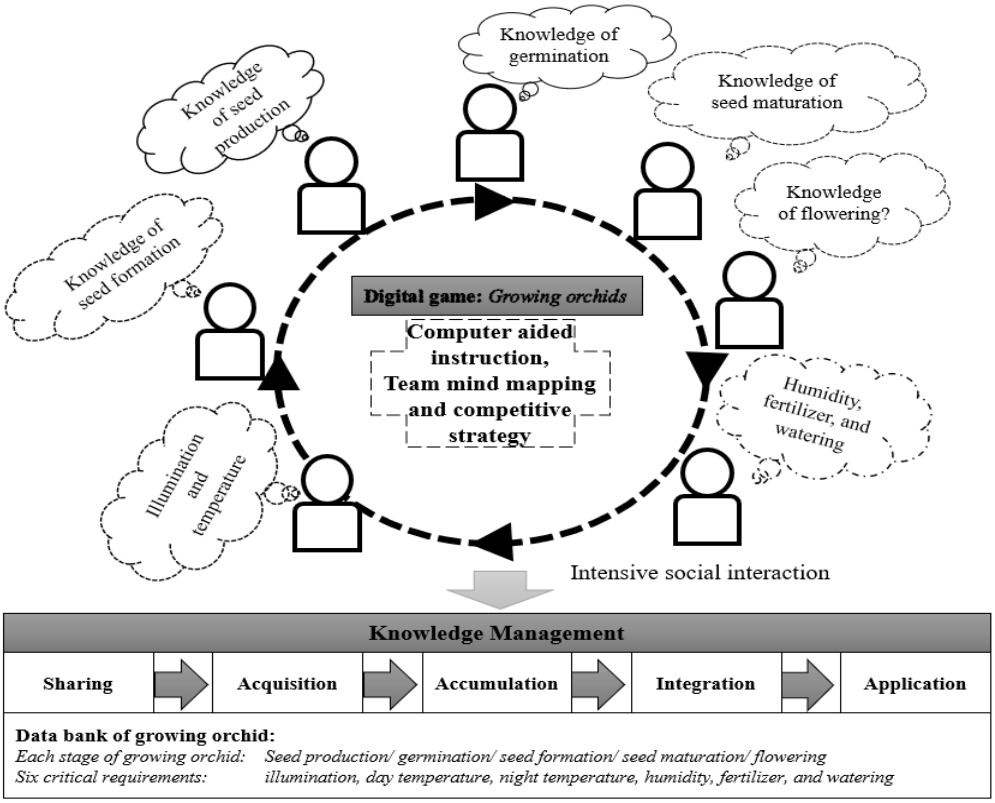

Figure 7. The processes of growing orchid knowledge via team mind-mapping

Table 11. The processes of knowledge management and competence acquisition

	Searching	Sharing	acquisition	accumulation	integration	Application
Knowledge management	Information: ● Orchid life cycles ● knowledge of growing orchids in different	Information: Information sharing ●seed production ●germination ●seed formation ●seed	Data: Obtain individual data sharing by team mind mapping	Data: Deposit the multi-knowledge into brains	Data: Withdraw each individual knowledge and integrate them into module knowledge	Feasible solutions: Use the knowledge of growing orchids to play the orchid game

	phases	maturation ●flowering ●illumination ●day temperature ●night temperature ●humidity ●fertilizer ● watering		
Competence acquisition	Information searching and analysis/ imagination	Competencies of Interpersonal skills: Critical thinking/ Oral & writing/Cooperation/ Adaptation/ interpersonal skills	Innovative module orchid knowledge	Problem-solving Improvements of self-efficacy, social interaction and learning attitude

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