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Understanding Students' Competition Preference in Multiple-Mice Supported Classroom

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ABSTRACT

Competition has been prevalent in all types of childhood activities including playing, learning, and living. Studies have shown that a well-designed competitive activity can motivate students to perform at an increased level. However, there have been few research studies on the relationship between learners' preferences and performance in relation to the level of competition in activities, especially in a computer-assisted learning environment. In this study, different levels of group and individual competitions were designed and implemented through an innovative multiple-mice learning system. Sixty 7th grade students were involved to interact with their own group members and compete with other groups to complete English vocabulary tasks. The preferences of students, of different levels of achievement, toward various competition activities were investigated upon finishing the tasks. This paper presents the potential of integrating the multiple-mice learning system into English learning tasks, and most importantly, it reveals the preferences of students regarding activities at various levels of competition in a computer-assisted learning environment.

Keywords

Competition preference, Multiple-mice technology, Learning achievement, Highly interactive classroom

Introduction

The design of social activities and how social activities affect learning have been considered important issues in educational research (Vygotsky, 1978). Among the various social learning activities, competition, an instinctive human behavior, plays a role in the design of a technologically supported learning environment. Obviously, excessively competitive learning activities can have many negative effects. Highly-capable students and less-capable students may perceive the same competitive activity with different feelings (Cheng, Wu, Liao & Chan, 2009). People who walk away from a victory will experience a different emotional state than the ones who walk away from a loss (Kohn, 1992). However, competition is generally considered an effective technique in motivating people to learn and to excel (Yu, Chang, Liu & Chan, 2002; Chang, Yang, Yu & Chan, 2003). Adding an element of competition is widely believed to be a motivation-enriching strategy in play, work, and education (Deci, Betley, Kahle, Abrams & Porac, 1981; Chang, Wang, Peng & Hsu, 2010). Additionally, competition has been suggested as a way to stimulate users' direct involvement and interest. The use of competition strategies in a classroom is a method that incurs both positive and negative effects. Studies on the challenge of applying competitive strategy in a learning environment therefore should focus on understanding how competition affects the students' attitudes and how to take advantage of students' increased motivation and positive learning effects, and decrease the negative effects of competition.

Classrooms are the environment where students spend most of their time and where they encounter learning activities designed to cover cooperation, competition and individual learning. Johnson and Johnson (1998) mentioned that competitions need to be kept light and fun, preferably in the format of a game. Additionally, students should be grouped homogeneously. Beyond the explorations of classroom learning activities, researchers are interested in understanding students' emotional development (Schutz & Pekrun, 2007). The more we understand students' preferences, the more adaptive support we can provide teachers and students. Integrating social activities into the classroom environment is an important issue when designing technology-enhanced classroom learning systems. Digital learning devices in classrooms provide teachers and students with a new interaction media. In the classroom, technology is a facilitator that helps aid quality interaction between teachers and students under a well-designed content and pedagogy (Roschelle & Pea, 2002). In respect to applying technology in classrooms, ensuring students have sufficient access to the necessary technology becomes an important issue.

In technology-enhanced classroom designs, a straightforward idea is to equip each child with one computer, and then they can use the computer at will. Making sure every student has a classroom computer is an important approach that can solve the students' technology accessibility problem (Chan et al., 2006; Roschelle, Penuel & Abrahamson, 2004). However, the cost of providing every student with one computer is too high for ordinary teachers and students to accommodate. Moreover, classrooms are also the place where students have peers to interact with. Equipping one student with one computer is helpful for learning, but we will argue that letting a group of students interact with their peers on a shared display simultaneously can help break the isolated learning scenario, better attract students' attention, encourage group work, as well as improve the students' social interaction. In this particular design, each student is equipped with a thin client, which can be a sensor or a mini device such as a mouse, and each of the students' sensors (Chang & Chen, 2010) or mini devices are connected via a classroom server. This kind of technology-enhanced classroom design, in comparison to the one-to-one computer concept, is different and is termed as a many-to-one technology-enhanced classroom setting.

The investigation of using multi-user environment such as shared interactive display can be traced back to the 1990s. The system MMM (the multi-device multi-user multi-editor) developed by Bier and Freeman (1991) was the prototype of using multiple-device on a computer. The large shared interactive display enables a group of people to use a computer simultaneously was reported in 1993 (Pedersen et al., 1993), and the multiple-mice technology supported groupware software was available in 1999 (Stewart, Bederson & Druin, 1999). Over the last decade, human-computer interaction researchers have been revising and improving the development of multiple-mice environment in which a computer can be equipped with many mice and the users can use the mice on the computer simultaneously. By using the shared display software, groups of students can be more attractive and participated in learning activities (Scott, Mandryk & Inkpen, 2003). By equipping each student a mouse, the students can form a group to have face-to-face group learning activity (Infante, Hidalgo, Nussbaum, Alarcon & Gottlieb, 2009). Most of the multiple-mice technology were developed to support face-to-face collaborative activities in the workplace as well as learning space.

In this study, a multiple-mice supported competitive learning environment was designed and implemented for the teachers and students to have face-to-face group competitive activities in the classroom. Solely providing a classroom with a multiple-mice environment is insufficient for practicing social interaction learning activities. Therefore, designing a multiple-mice enhanced classroom should consider not only the technology, but contemplate how to design truly immersive group activities. In this study, a multiple-mice learning system with five different competitive learning activities was used. Through this system, the students can interact with their peers and compete with other groups by using a mouse both individually and simultaneously with other mice on a shared display to complete English vocabulary tasks. The objective of this study is to investigate the students' preferences toward various competitive activities in this type of multimedia environment. If we can understand the students' preferences more, we can provide more precise support when designing future activities. Besides, concerning the multiple-mice enhanced classroom design, in comparison to the one-to-one computer environment, we argue that this multiple-mice learning system is much affordable for teachers due to its low cost and is feasible in a regular classroom. In addition, the interactions between students are enhanced by well-designed language tasks.

MUSCLE: Multiple-Mice Supported Competitive Learning Environment

Using information technology in classrooms is a trend of educational technology development where students' accessibility to information technology is a critical issue. No technology-enhanced classroom project can be successful if the students don't have easy access to the necessary tools. However, the cost of applying information technology in classrooms was previously too high for teachers and students to accommodate. As mentioned above, human-computer interaction researchers have demonstrated the potential of connecting a computer to numerous mice allowing students to simultaneously use the mice with their peers on the same computer.

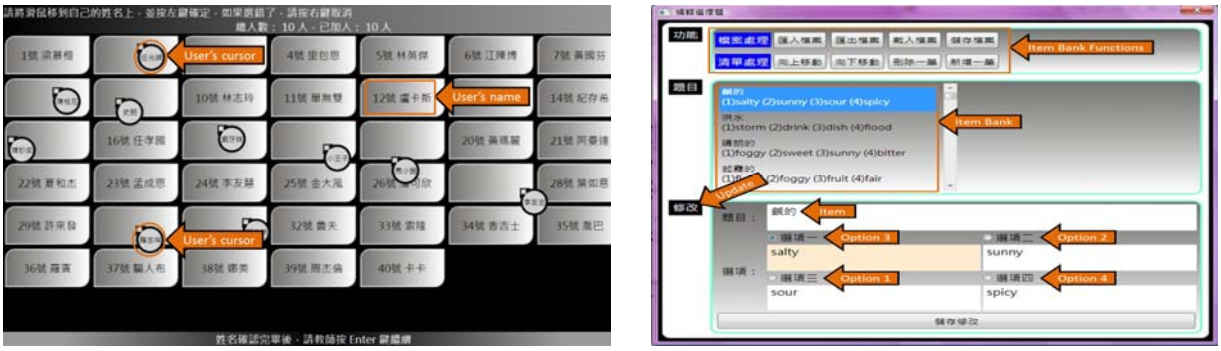
In this study, by using the multiple-mice technology, a multiple-mice supported competitive learning environment named MUSCLE (Multiple-mice Supported Competitive Learning Environment) was designed. Figure 1 displays a MUSCLE system scenario. In the scenario, the teacher who wants to use the MUSCLE system only needs a projector, a projection screen, a personal computer or notebook, a USB hub, and several general purpose mice. These facilitators are quite common in a regular classroom.

Figure 1. Multiple-mice supported classroom scenario

To facilitate students' performance using MUSCLE, four major functions, Identification & Grouping, System Utility, Individual Competition Mode, and Group Competition Mode, are implemented. Furthermore, Individual Competition Mode is divided into an individual task competition (ITC) activity and an individual rush competition (IRC) activity, and Group Competition Mode is divided into a group coop (GCO) activity, a group competition (GCM) activity, and a group rush competition (GRC) activity. The multiple-mice technology provides an environment where each student has at least one personal cursor to interact with their peers in several competition designed activities. Table 1 lists the functions of MUSCLE system.

Table 1. Functions of MUSCLE system

Function	Description
Identification & Grouping	All the usernames are listed on the shared notebook screen. The users identify their names by using their cursors. The name list is edited by the teacher or the student before the activity.
System Utility -Editing usernames -Editing item bank -Setting system parameters	The users can use the system utility to edit the usernames list and the item bank, or configure the parameters of the MUSCLE system.
Individual Competition Mode -Individual task competition -Individual rush competition	Individual competition mode consists of an individual task competition activity and an individual rush competition activity. Each student in this mode is allocated an individual area on the shared display to complete the activity.
Group Competition Mode -Group coop -Group competition -Group rush competition	Group competition mode consists of a group coop activity, a group competition activity and a group rush competition activity. Each group of students answer their questions in a shared area.



(a) Identification & Grouping (b) Item Bank Authoring Interface

Figure 2. Identification and authoring utility interface

Identification & grouping

In the MUSCLE environment, all the mice cursors can be displayed on a shared notebook, and each student can move their mouse to identify their cursor. Once the students recognize their cursors, the students can click on their names to match their cursors with their names. Figure 2 (a) shows the name list which was edited in advance by the teacher or the students via the editing usernames sub-function of system utility. After completing name assignments, the teacher can enter the next stage of assigning the groups. The teacher can merge students into one group or divide the students into several different groups depending on the needs of the competition modes.

System utility

The system utility has three sub-functions. The first sub-function is editing the username list; the second, editing the item bank; the third, setting system parameters. The teacher or the students can use the username list edit function to edit their usernames. The users can identify their names on the shared display via their cursors. The MUSCLE system provides two question formats, multiple choice questions and matching questions. The teacher or the students can edit the item bank by means of the editing interface. The parameter setting function enables the teacher to set the time period of a round and the challenge level of the competition mode. For example, the teacher can set the period of a round to three minutes, or the next item will be shown when the three students answer correctly.

Individual competition mode

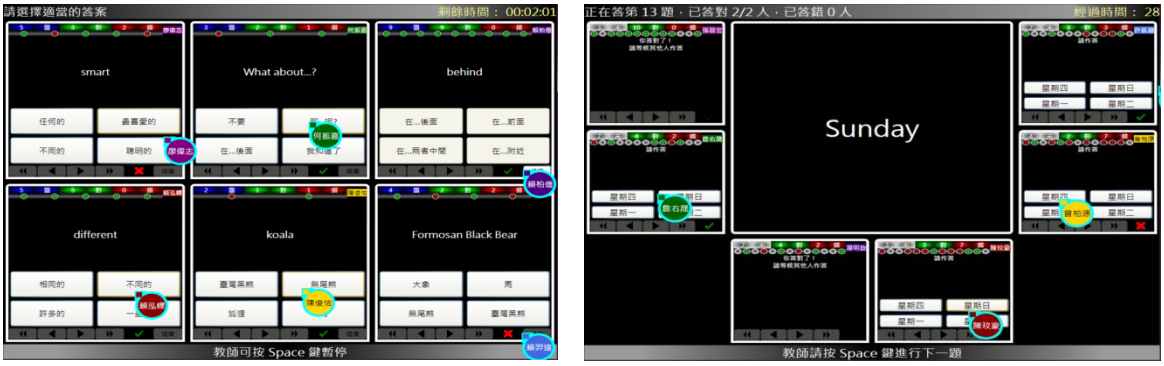
Competition is an activity in which the students compete with their peers over a set period of time. To further provide different individual competition activities, the individual competition model was further split into an individual task competition (ITC) activity and an individual rush competition (IRC) activity.

ITC activity

In the ITC activity, (refer to Figure 3-a), the shared screen is divided into several zones equivalent to the number of participants. The students can do the multiple choice question exercises individually with their own cursors in their personal zone areas at their own speed. The whole exercise ends only when all students are finished. A personal progress bar to indicate individual advancement is displayed in their personal zone areas. Each student in the group can be aware of their peers' progress on the shared display.

IRC activity

In the IRC activity, (refer to Figure 3-b), the multiple choice questions are displayed in the central area for all students, but the students answer with their own mice in their personal areas. The IRC activity can be set as a one-chance sub-activity, a two-chance sub-activity or a three-chance sub-activity. Only the fastest students can be awarded points during each round. For example, in the one-chance sub-activity, only one student can get a point. As soon as he/she gets the point, the question changes immediately.



(a) ITC: Individual Task Competition (b) IRC: Individual Rush Competition

Figure 3. Individual competition mode

Comparing the ITC and IRC activities, the competition intensity of IRC is higher than ITC because the students have to compete with others to choose the right answers within seconds. Among the IRC three levels, one-chance sub-activity, two-chance sub-activity and three-chance sub-activity, the three-chance sub-activity has the lowest intensity. The one-chance mode is set as the highest intensity which only allows a single person to give the right answer. The students should not only figure out the answer but also react faster than others.

Group competition mode

A quality classroom environment should provide several opportunities for social and group interaction. For group interaction, the MUSCLE system provides three group competition activities. They are Group Coop (GCO) activity, Group Competition (GCM) activity, and Group Rush Competition (GRC) activity.

GCO activity

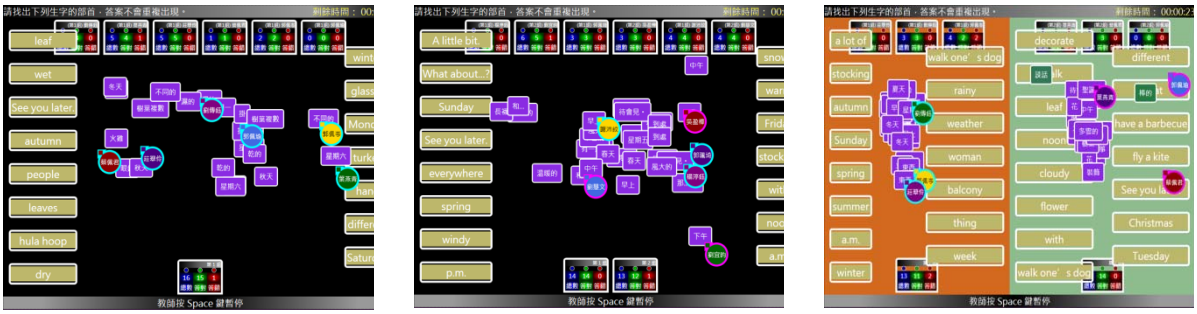
GCO represents Group Coop activity which is a cooperative mode. All students are regarded as a large group. They cooperate to complete tasks proposed by the computer. In this mode, refer to Figure 4 (a), all the students' cursors with their names are displayed in the same zone without boundaries on the shared display. The students are required to pick the Chinese words positioned in the center of the screen and drag the Chinese words to the appropriate English words. Within the allotted time, the set of questions will change if the students can make proper matches. No rushed time or rule constraints are applied in this mode.

GCM activity

GCM represents Group Competition activity. In this mode, refer to Figure 4 (b), the students are divided into two teams to partake in the activity, but all the students' cursors with their names are displayed on the shared display in the same zone. The members of the two groups are required to recognize the Chinese words present on the shared display and drag the Chinese words to the appropriate English words. The team will be given one point if one of their team members drags the Chinese word to the appropriate English word. However, the proposed Chinese words are limited and will change if the students from two teams can match most of the questions. The team that has the highest score at the end of the game is the winner.

GRC activity

GRC represents Group Rush Competition activity. Refer to Figure 4 (c), the display is divided into two zones. Similar to the GCM mode, the students are also grouped into two teams. In GRC activity two groups of students are assigned to their group zones and the students cannot cross the boundary. In their own zone, the students can finish the exercise with their group members. The team members drag the Chinese words to the appropriate English words in their team space. The difference between GCM and GRC modes is that each team has their own questions in their team space and only the group members can answer their own questions. No matter how many points each team member earns, the winner is the team that has the highest end score.



(a) GCO: Group Coop (b) GCM: Group Competition (c) GRC: Group Rush Competition

Figure 4. Group competition mode

To summarize, from the perspective of competition intensity, the GRC activity is higher than the GCM activity, and the GCM activity is higher than the GCO activity. From the group competition goal perspective, the GRC has the most clear competition goal and the GCO has the most loose competition goal.

Evaluation

To study the students' preferences toward the different multiple-mice technology supported competition activities, sixty 7th grade students from two classes were involved in the study. Among them, thirty are female, and thirty are male. The subject is English vocabulary. Three 7th grade English units of approximately seventy words were involved. The three lessons changed as the English course proceeded. One lesson was old; another was new; the other was untaught.

A measurement of students' learning achievement was involved in this research since a student's level of achievement will affect his/her competition performance. According to the aim of the study, the competition activities were grouped by individual competitions and group competitions, and the students were cataloged as high-achieving students, average-achieving students and low-achieving students. The monthly English test results of the students were collected as the index of the students' learning achievement. The grades of high-achieving students are the top one-third of the class and the low-achieving students are the bottom one-third of the class. The average-achieving students are in the middle.

Evaluation framework and process

In order to study the students' competitive preferences among these different competition activities, an evaluation framework was applied. The evaluation framework was composed of three studies derived from a quantitative questionnaire shown as Figure 5. The first study focused on the students' preferences among the individual competition activities and group competition activities; the second study measured the students' preferences toward individual competition activities; the third study looked at the students' preferences toward group competition activities. In the process of the evaluation, the questionnaire was applied to assess students' behavior and competition preferences.

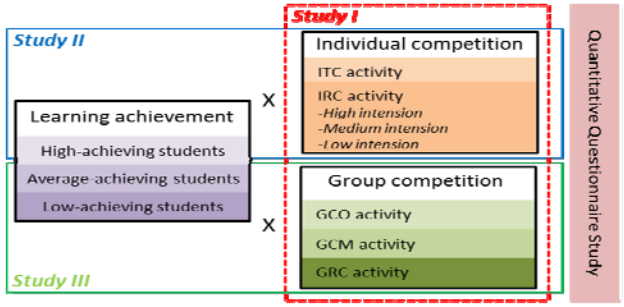


Figure 5. Evaluation framework

The perception questionnaire was designed to evaluate the students' preferences. The questions cover subject preference, system usability, and competition activity preference factors. The evaluation was designed as three phases. Before the phases began, there was a warm-up session. This study was aimed at finding information concerning students' competition preferences.

All of the students were involved in the activities. In the first week, the students were allowed to play around with the MUSCLE system as a warm up and began to understand how the activities would proceed. Each phase was enacted for two weeks to allow the students to become well-accustomed to the five different activities. Six students, as a group, perform the activities on the same screen at the same time. This means every student has a chance to practice each of the different competition modes at least twice.

Seven rounds of using the system were carried out. The first round was given to permit the students to warm up and allow the students to become familiar with the system. Then rounds two and three executed the first phase of the study. Each phase had two rounds and used the same mode twice. The scope of each phase was the same, but the two rounds were different in the exchange of two languages.

Table 2. Practice schedule

Round	System Activity	Unit	Note
1	Warm up 10 minutes	U4	Where's your dog?
2	ITC, IRC (3/6)	U5	Are there any koalas in the zoo?
3	ITC, IRC (3/6)	U6	He's dancing with his grandma.
4	IRC (1/6), IRC (2/6), IRC (3/6)	U5	Are there any koalas in the zoo?
5	IRC (1/6), IRC (2/6), IRC (3/6)	U6	He's dancing with his grandma.
		U7	What time is it?
6	GCO, GCM, GRC	U6	He's dancing with his grandma.
7	GCO, GCM, GRC	U7	What time is it?
		U8	What's the weather like in summer?

Evaluation results

In order to have a clear idea of what the students' competition preferences are, the students were asked to give a ranking of the seven sub-activities according to their preference after filling in the five-point perception Likert item questionnaire. The students ranked each of the seven activities from one to seven. An activity with a rank of seven indicated the activity the student liked the most. If the student ranked the activity with a one, he/she did not prefer it at all. This ranking system shows what their preferences are. The students' competition preferences toward different activities are elaborated below.

Study I: The preference of the students toward individual and group competition mode

The first study was proposed to investigate the preferences of the high-, average- and low-achieving students toward the individual and group competition modes in general. As presented in Table 3, only the low-achieving students showed a significant difference in preference between individual and group competition modes ($t(19) = 2.559$, $p < .019$). The results indicate that the low-achieving students liked to perform with group members to work out the answers rather than answer the questions individually.

Table 3. Students' preference toward individual and group competition modes

	Individual Competition Mode		Group Competition Mode			Paired *t*-test results
	Mean	SD	Mean	SD	*t*	Comparisons
High-Achieving	4.23	1.07	3.70	1.42	-.94	No Significant Difference
Average-Achieving	3.70	1.09	4.40	1.46	1.23	No Significant Difference
Low-Achieving	3.41	1.03	4.78	1.37	2.56*	Individual Competition < Group Competition

*$p<.05$

Study II: The preference of the students toward individual competition sub-activities

The goal of the second study is to investigate the students' preferences toward different individual competition sub-activities in which the ITC activity and IRC activity were involved. In the ITC, the students were asked to answer the questions at their own pace. On the contrary, in the IRC mode the students competed with others to strive for the chance to give answers. The competition levels in the IRC mode can be set as a one-chance sub-activity, a two-chance sub-activity and a three-chance sub-activity. Among the three levels, the three-chance sub-activity has the lowest intensity in which students had to compete with others to be one of the first three people who gave the right answer. The one-chance sub-activity was set as the highest intensity which only allowed a single person to give the right answer.

Based on the questionnaire, there was a significant difference in preference toward the ITC activity ($F(2, 59) = 4.52$, $p < .015$) between the three groups but no other significant differences were found in the three competition sub-activities of the IRC activity (see Table 4). The results showed that the high-achieving group preferred the ITC

activity most (mean = 6.15) compared to the low-achieving group (mean = 4.25), indicating that the high-achieving students liked to answer the questions at their own pace.

Table 4. Students' preference toward individual competition sub-activities across levels

	SS	DF	MS	F	Interpretation
ITC Activity					
Between Groups	36.100	2	18.050	4.522*	High-Achieving (mea n = 6.15) > Low-Achieving (mean = 4.25)
Within Groups	227.500	57	3.991		
Total	263.600	59			
IRC Three-Chance					
Between Groups	3.033	2	1.517	.618	No Significant Difference
Within Groups	139.950	57	2.455		
Total	142.983	59			
IRC Two-Chance					
Between Groups	.400	2	.200	.064	No Significant Difference
Within Groups	178.2.00	57	3.126		
Total	178.600	59			
IRC One-Chance					
Between Groups	5.833	2	2.917	.742	No Significant Difference
Within Groups	224.100	57	3.932		
Total	229.933	59			

*$p < .05$

Table 5 presents the results concerning the attitudes toward individual competition sub-activities for each group. When closely examining the attitudes toward individual competition activities for each group, the high-, average- and low-achieving students preferred the ITC activity to the IRC activity, indicating that most of the students liked to answer the questions at their own pace instead of striving for a single chance to answer. Between the three competition intensity levels of the IRC activity, the results seemed to show that high-, average- and low-achieving students prefer a moderately competitive mode rather than an intensely competitive mode.

Table 5. Students' preference toward individual sub-activities for each level

	ITC		IRC One-Chance		IRC Two-Chance		IRC Three-Chance		Paired *t*-test results	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*t*	comparisons
High-Achieving	6.15	1.87	3.05	1.85	3.40	1.67	4.30	1.92	3.181**	ITC > IRC-three
									4.535**	ITC > IRC-two
									4.693**	ITC > IRC-one
									2.349*	IRC-three > IRC-two
Average-Achieving	5.20	1.94	2.55	2.33	3.20	1.82	3.85	1.35	3.178**	ITC > IRC-three
									3.183**	ITC > IRC-two
									3.200**	ITC > IRC-one
									2.221*	IRC-three > IRC-one
									2.156*	IRC-two > IRC-one
Low-Achieving	4.25	2.17	2.38	1.72	3.30	1.81	3.80	1.36	2.842**	ITC > IRC-one
									4.567**	IRC-three > IRC-one
									2.127*	IRC-two > IRC-one

*$p < .05$, **$p < .01$

Study III: The preference of the students toward group competition activities

The goal of this study is to investigate the students' preferences toward group competition activities. Three group competition activities, GCO, GCM and GRC, were involved in this study. Among the three activities, GCO is the lowest intensity competition activity, and GRC is the highest intensity competition activity. The results showed that the three achieving groups showed no significant differences in preference toward the three group competition activities (see Table 6).

Table 6. Students' preference toward group competition activities across levels

	SS	DF	MS	F	Interpretation
GCO Activity					
Between Groups	8.633	2	4.317	1.618	No Significant
Within Groups	152.100	57	2.668		Difference
Total	160.733	59			
GCM Activity					
Between Groups	14.433	2	7.217	2.770	No Significant
Within Groups	148.500	57	2.605		Difference
Total	162.933	59			
GRC Activity					
Between Groups	16.933	2	8.467	1.748	No Significant
Within Groups	276.050	57	4.843		Difference
Total	292.983	59			

Quantitative questionnaire study

A five-point perception Likert item questionnaire shown as Table 7 was applied to study the sixty students' English learning attitudes and competition preferences. One or two students missed some items in filling out the questionnaire that makes the summary in some items are not exactly equal to one hundred percent. According to the statistics, the students expressed that they liked the English course (Item 1), but only 2.75 students said that they would like to memorize English vocabularies (Item 2). English vocabularies are important for students in learning English, but the willingness of the students to memorize English vocabularies in traditional way was not so high. The questionnaire results also revealed that almost half of the students expressed that their English achievement was not good (Item 3). However, the students showed that they like to learn words with the MUSCLE system (Item 4), and the students expressed that they can learn words with the MUSCLE system (Item 5). The students also expressed that they would like to practice the exercises with the MUSCLE system (Item 7). It is interesting that the students expressed that they don't like to memorize English vocabularies in traditional way (Item 2), but they can accept to learn words in MUSCLE system (Item 4 & Item 5). In general, the students can accept the MUSCLE system (Item 6 & 7), and they can also accept applying the competition mechanism (Item 8 & 9) in the classroom.

With MUSCLE system, the motivation to learn vocabulary was promoted, and the students had fun in participating in MUSCLE learning activities (Item 4 & 6). Furthermore, most of them are willing to learn with others by using MUSCLE. Besides, more than half of the students like the competition mechanism (Item 8 & 9) though there are some various preferences. The questionnaire results roughly indicated that the students need support in learning English, and they could accept the MUSCLE system as a kind of learning support system.

Table 7. Statistics of the students' preference for MUSCLE (n= 60)

Item	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)	Ave.	SD
1. I like to have English course.	27.9	27.9	31.1	8.2	4.9	3.66	1.12
2. I like to memorize English vocabularies.	8.2	18.0	34.4	16.4	21.3	2.75	1.23
3. My English achievement is great.	11.5	11.5	27.9	27.9	21.3	2.64	1.27
4. I like to learn words with MUSCLE system.	39.3	23.0	32.8	1.6	3.3	3.93	1.05
5. I can learn new words from the activities.	33.0	20.0	30.0	6.7	10.0	3.6	1.29
6. It is fun that six people do the practice altogether.	42.6	13.1	31.1	6.6	4.9	3.83	1.21
7. If I have chances, I'd like to practice with MUSCLE system.	36.7	23.3	30.0	5.0	5.0	3.82	1.14
8. Competition makes the practice more interesting.	11.5	18.0	36.1	21.3	11.5	3.34	1.33
9. I like to compete with my own group members.	13.1	21.3	42.6	14.8	8.2	3.16	1.10

Discussions

Different competition modes of MUSCLE have been applied in a classroom, and the students' preferences toward different competition modes have been explored. In this section, the discussions of technology accessibility in classroom, MUSCLE system environment for teachers and students, and different levels of students' learning achievements preferences toward different competition modes are elaborated below.

MUSCLE provides affordable information technology accessibility in classrooms

System usability is the critical linchpin in a technology-enhanced classroom. Teachers and students cannot tolerate unstable and low usability system in the classroom. MUSCLE has two versions. The previous version was designed using wireless sensor technology (Chang & Chen, 2010), and the later version was implemented through multiple-mice technology. Ideally, the MUSCLE system can connect more than one hundred mice to a computer simultaneously. However, in real practice, the MUSCLE system works best when less than ten students use mice with a computer at the same time. Using less than ten mice, the experimental participants express a high usability of the MUSCLE system. The MUSCLE system provides an affordable new opportunity for teachers and students to interact in the classroom with minimal information technology accessibility.

MUSCLE system usability is acceptable to teachers and students

According to the questionnaire results, the students showed a positive attitude toward the MUSCLE system. Most of the students liked to learn vocabulary with classmates by using MUSCLE and they felt interested in using multiple mice together, indicating the MUSCLE system can be accepted by the students in classroom. However, few students expressed an opposite opinion about this system, which reveals a concern that the equipment used in the MUSCLE system was affordable, but it may not meet all of the students' needs for learning. Students may move more freely and engage in activities using their whole body if MUSCLE is supported by more advanced technology such as wireless mice, big screens and high-performance CPUs. The motivation of learning may be promoted and the level of learning achievement may be improved. Besides, the teacher's observation indicated that the students would ask about MUSCLE system and show their willingness to use it. Many students surrounded the screen and the students fully engaged themselves. Some of them would look up new words in the textbook to answer more correctly. In specific, the students who generally lacked interest in English would help the teacher to pack up the equipment after classroom and talk about the activities.

High-achieving and low-achieving students' preferences for competition modes are different

According to the studies, the low-achieving students showed a preference for group competition modes and high-achieving students preferred the ITC activity the most. In class, the circumstances that students have different preferences and different achievements does make a difference. It has a crucial effect on teachers' instructional design. The results of this study may remind teachers of students' different preferences for competition. How to design a suitable lesson design for the whole class is a big issue for all teachers. In the classroom, the class cannot be divided into two or more parts. Nevertheless, the needs of different students should be considered by all teachers. However, it is not easy for teachers to individually find a balance. Fortunately, technology may provide a large amount of help for teachers. Teachers who can make good use of instructional technology, such as the MUSCLE system, may greatly aid students. Integrating suitable technology with instruction, students' level of achievement may become better and better.

Conclusions

Competition is an instinctive human behavior and takes a role in our daily life. Excessively competitive activities can have many negative effects and no doubt frustrate many students. However, appropriate competition intensity can improve the quality of classroom interaction. A competitive activity is generally considered an effective technique in motivating people to learn and to excel (Yu, Chang, Liu & Chan, 2002). Adding an element of competition is widely

believed to be a motivation-enriching strategy in play, work, and education (Deci et al., 1981). Social learning researchers have indicated the importance of applying interactive activities in classrooms and it has been shown that interaction between students can be enhanced through well-design competitive activities in a technology-integrated learning environment. However, the students' ability to readily access technology was formerly an obstacle in a technology-enhanced classroom. This study demonstrated the potentials of using MUSCLE to motivate students to memorize English vocabulary. Using MUSCLE, each student can have a mouse in hand to interact with their peers. Instead of equipping the classrooms with more computers, MUSCLE allows students to interact with their peers and compete with other groups on a shared display.

In this study, combining multiple-mice technology and competition activities design, the MUSCLE system was designed, implemented and applied in a classroom. In addition, an evaluation framework was practiced in this study. The framework covered students' learning achievement, individual competition, and group competition. Three study designs were applied based on the framework, which covered the preferences of the students toward individual competition activities, the preferences of the students toward group competition activities, the preferences of the students toward individual and group competition through a quantitative questionnaire. With the system, sixty 7th grade students participated in this study through analyzing English vocabulary. The results showed that the students' competition preferences were related to their level of achievement. Comparing to the individual competition mode and group competition mode, the low-achieving students preferred group competition mode significantly over individual competition mode. It seems to indicate that low-achieving students need more scaffolding provided by more-capable peers when accomplishing tasks. In addition, among different individual competitive activities, the low-achieving students preferred the ITC activity which is a less competitive activity. The results indicated that the three achieving groups showed no significant differences in preference toward the three group competition activities. Before the experiment, the five-point perception Likert item questionnaire results indicated that the students expressed that their English achievement was not good, and most of them didn't like to memorize English vocabulary in traditional way. After the experiment, the students expressed that they could accept practicing the exercises with the MUSCLE system in the classroom and compete with their peers on a shared notebook with their own mouse simultaneously.

The MUSCLE system demonstrated the potential of using multiple-mice technology in a classroom, and the system evaluation results indicated that the MUSCLE system can provide affordable information technology accessibility in a classroom. By using the multiple-mice technology, all students can have access to information technology at minimal cost to the teachers. The contribution of this study is to demonstrate the potential of applying multiple-mice technology into a regular classroom and providing five competition activities for the teachers and the students to apply. Through this study, the authors found that different learning achievement students have different preferences in the multiple-mice supported classroom, and it is interesting that the high-achieving students have an opposite preference to the low-achieving students. As instructors or designers, more trade-offs should be considered. This was pioneer study with sixty 7th grade students in a rural area in Taiwan where culture differences and urban-rural gap issues may come into play. This is also a study demonstrating the possibility of using non-PC-like human-interaction technology in a real teaching field. More novel technologies such as gestures-based computing, wireless sensors, multiple-touch technology would be available in the future to help technology-enhanced classroom learning. In the next study, the authors are trying to exploring the possible classroom solutions to compromise on these differences.

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