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# Chapter 4

## **Human-Centered E-Learning**

## Preface

The Workshop on Human-Centered E-learning is part of the 19th International Conference on Computers in Education (ICCE2011) that was held from November 28 to December 2, 2011, at Chiang Mai, Thailand.

The Workshop tends to investigate how to use Human Centered Design (HCD) to improve the development of e-learning tools so that these tools can effectively support teaching and learning for different types of users.

The development of e-learning tools should be accessed anytime and anywhere by users. Moreover, as a result of such convenience, a wide range of people have begun using e-learning tools for supporting teaching and learning. Thus, it is important to ensure that such e-learning tools can accommodate diverse users' needs. To address this issue, there is a need to incorporate the HCD into the development of the e-learning tools. More specifically, the HCD is used to not only investigate the behaviors of using e-learning tools between different types of users but also analyze how users' individual differences influence their perceptions for the e-learning tools. After doing so, such investigations can be used as guidelines to develop the e-learning tools to meet users' needs.

The contributions that are presented here cover various topics, such as game-based learning systems, quiz-based learning systems, gender difference, and learning styles. In summary, we attempt to provide answers for the following questions:

- How gender differences affect helping-seeking and supportive behavior?
- How gender differences change social behavior on a coop-competition game?
- How prior knowledge and cognitive styles can be used in a personalized E-learning system?
- How a surrogate competition approach can enhance student learning?
- Do students have the abilities to choose the most-beneficial educational systems on their own?
- What kind of students is suitable to use a group quiz game E-learning system?

We hope that the Workshop will contribute to the global research in E-learning by comprehensively reviewing state-of-the-art E-learning approaches that accommodate

users' needs, will help integrating users' needs into E-learning applications, and will give some insight into analytical and architectural aspects of E-learning.

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# Answering Bee: A Pilot Study of Classroom Group Quiz Game

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**Abstract:** In this paper, the authors describe the group quiz game system, Answering Bee, which can be used in the classroom to explore the quiz game and its group learning interaction. Answering Bee system is available for four to six players for each group on the plate computer to have group quiz competition game. A pilot study adopted the quantity by the questionnaire of the learner pleasure was applied to understand the students' reaction and the system functions. Twenty senior high school freshmen are involved in this pilot study. The results indicate that the high interactive group students have the positive attitude toward concentration and social interaction when using the system but contrarily the high achievement group students get the positive attitude of the knowledge domain. Besides, the findings also figure out that the male is more acceptable than the female in the digital quiz game learning.

**Keywords:** Plate computer, group interaction, quiz game, assessment

## Introduction

Using technology into the classroom is one of the current study issues, and it improves the current teaching model. Global alliance of one-to-one popularizes the conception of that every student has his/her own computer in the classroom [2]. The devices can connect to the Internet that can increase the students' right of access information and the interaction between teachers and students. The advantages of the mobile devices are innovative, portable, increasing the computing ability, durable and the high popular [5]. These advantages have affected the current situations in the classroom.

There are various activities in classroom, and assessment is one of the important items [1]. In the past, students took a test by using pens and papers. After finishing a test, teachers collected test papers and gave students the scores; students receive only the feedback, the score. However, score can't show what students have really learned. In addition, a large number of tests result in some pressure to students, and make students have low interest and motivation in learning and tests. Digital games have some characteristics of obvious goals, game rules, game condition, and entertainment [6]. These features engage a lot of students to spend ample time on gaming. This century is a "game generation" whose lives are already intervened by a lot of digital games. Therefore, how to combine assessments with games is an important guideline for research. Adopting game features in the tests may let the test become more interesting and improve the students' motivation for the test. Furthermore, teachers can access students' learning conditions by analyzing students' performance in the game, and to give appropriate scaffolding and support [4].

Assessment is an integral and ongoing means to find ways to improve learning and teaching and is the core body to assess need, measure growth and evaluate teachers, programs and curricula [8]. In this study, a group multiple choice game system named Answering Bee is

developed and used to explore the possibility of applying assessment to a game-based environment. By embedding the assessment into the group and competitive way to improve students' achievement [3], we can make it effectively and interesting to use the Answering Bee to be a tool of the assessment. Besides, by observing the process records and analyzing what students have participated in, we can find an appropriate way to suit to the learners to motivate and achieve students' performances.

## 1. Answering Bee System Design

### 1.1 User Interface Design

Figure 1 shows the Answering Bee system screenshots of which Figure 1-1 is the welcome screen, and Figure 1-2 is the player setting screen. There are two parts of the User Interface Design. The upper part of the screen (as the Figure1-3 & Figure1-4) shows the figure heads according to the numbers from one to six of logging in. Each figure represents an answering pupil. In front of each figure is a table to show the player's name and the start which symbols the code of answering each question. When the player gets the right answer, he/she gets one star; and vice versa, getting the wrong answer, he/she will be out of the game till accumulated three wrong answers.



Figure 1. Screenshots of Answering Bee System

The bottom part of the screen shows the question and its choices. The player can answer the questions by beating the choices. The right part of the bottom is the figure of the host with the facial expressions of joyful when the player gets the right answers to the questions and with the facial expression of disappointed when the player gets the wrong answers to the questions. The left part of the bottom part shows the facial expressions of the answering players with the happiness when having the right answers and with the annoyance when having the wrong ones. During the process, each one take turns answering the question. Three different of lights, brighter, shadow and black-and-white indicate the status of the players showing on the whole figure as the Figure 1-4. When the players are answering the

question, the figure shows brighter light; the left part of the bottom also shows the figure. While the player is off-line, the figure becomes the shadow color. And the loser will be showed by the black-and-white figure. The game will be lasted till all of the rest of the players are out till the last one, the survivor win the champion herein.

### 1.2 Game Flow and System Architecture

The game flow of Answering Bee composes of three steps. They are:

- Step 1. Entering Game: Set the players number and enter the players' names and icons.
- Step 2. Game Start: Every player owns three stars and takes turn answering the question by beating the Choices. When the player gets the wrong answer, he/she will lose one star. If the player gets the right answer, he/she will win one point per one question.
- Step 3. Game Over: The game is lasting till the other players are out of the game; that is to say, he/she got the wrong answer accumulated three times. At last, the winner wins the champion because he gets the most right answers.

Figure 2 shows the five major parts of the Answering Bee. They are start game, ranking, setting, about us, and exit.

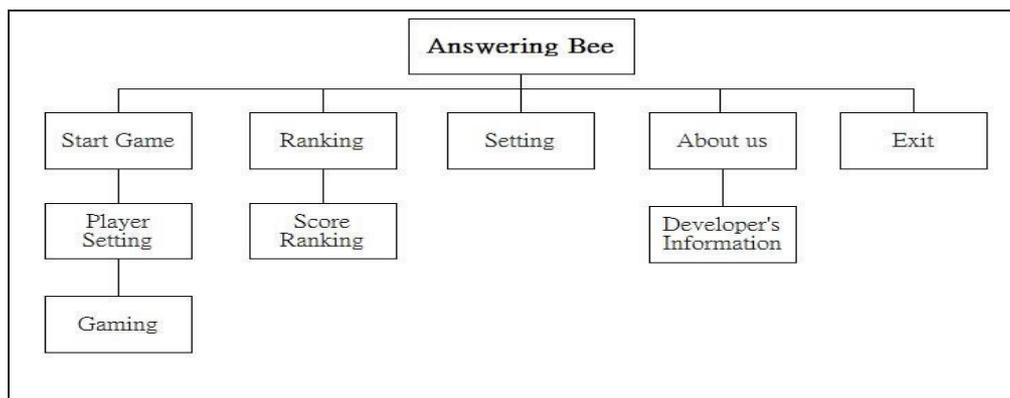


Figure 2. Answering Bee Framework Diagram

The details of the functions are elaborated below:

1. Start Game: Press the button "start" to enter the playing screen. And then set the number of players and each player's name, and choose the item bank.
2. Ranking: The ranking is recorded in the database based on all of the players. Whenever the game is over, the players' scores will be updated.
3. Setting: Teachers set the classes that are ready to play the games and questions in advance and students are open to select the item banks according to students' levels and preferences.
4. About Us: Some developers' information likes contacting ways.
5. Exit: Leave this system.

## 2. Pilot Study

For understanding students' reaction and system function, a pilot study was conducted. Twenty freshmen of Department of Computer Science at a vocational school in Chiayi County located in southern Taiwan were involved in this pilot study. Among them, twelve are male and eight are female. These students, aged sixteen, who are familiar with using

computers, not good at English, and low society background are the volunteers to be the participants and they are grouped to two according to their class performance and interactions by their English teacher who has taught them for one semester. A post-test pleasure questionnaire revised from Su (2006) was adopted. The Answering Bee system developed by our team was installed on two plate computers and applied for the pilot study, and one video recorder was used to tape the students' interactions.

### 2.1 Procedure

There were three steps in this practice, including "Warm Up," "Playing," and "After Activity." Below is the introduction of each step.

1. Warm Up: The participants are introduced how to use and practice the Answering Bee and are divided into the male (six ones) and the female (four ones).
2. Playing: These two groups play the Answering Bee system with two tablets simultaneously for two times.
3. After Activity: The players fill out the questionnaire.

This experiment is by convenience sampling and divided into two groups, one is high achievement and the other is high interactive; the former plays digital games is less than four times per month and for the average less than one year, and the later plays five to seven times per week for the average for three to five years.

### 2.2 Preliminary Results and Discussions

Some results were obtained by the questionnaires unfolded in six facets of the learner pleasure which are 1) concentrating, 2) feedback, 3) controlling the game, 4) immersing the game, 5) social interaction and 6) knowledge domain. This study uses five-item Likert-type scale that attempts to estimate the level of learner pleasure as the following: one point for very disagree, two points for disagree, three points for neutral, four points for agree, five points for very agree. The results indicate the positive values of Answering Bee, quiz game assessment as on the Table 1. The statements of the questionnaire are below:

There are two aspects have a remarkable result. The average scores of social interaction in high interaction group were 3.82 and higher than the group of high achievement (3.62). On the other hand, the average scores of knowledge domain in high achievement group were 3.82 and higher than the group of high interaction (3.66).

Table 1. The Results of the Questionnaire of the Learner Pleasure

| Item                 | High Achievement | High Interaction |
|----------------------|------------------|------------------|
| Concentrating        | 3.62             | 3.82             |
| Feedback             | 3.90             | 3.97             |
| Controlling the game | 3.82             | 3.80             |
| Social interaction   | 3.62             | 3.82             |
| Immersing the game   | 3.64             | 3.68             |
| Knowledge domain     | 3.82             | 3.66             |

Finally, the study analysis by the gender by T-Test and indicates that the male has more pleasures than the female no matter what he/she belongs to the high achievement or the high interactive one as the Table 2.

Table 2. T-test of Gender Differences in Two Groups

|                  | Gender | Average | D    | T     | f | P     |
|------------------|--------|---------|------|-------|---|-------|
| High Achievement | Male   | 4.12    | .635 | 2.503 | 8 | .037* |
|                  | Female | 3.13    | .560 |       |   |       |
| High Interaction | Male   | 3.95    | .784 | 1.030 | 8 | .333  |
|                  | Female | 3.51    | .346 |       |   |       |

p<.05

The questionnaire is to investigate the degree of the learning pleasure. Table 1 reveals several interesting issues of high interaction and high achievement, and gender differences. The results reveal that the high interaction students' concentration and social interaction were higher than the high achievement students, but the high achievement students had higher level of the knowledge domain than the high achievement students. The gender makes it different to play the quiz game and indicates that the male with a higher passion than the female.

### 3. Conclusions

The main purpose of Answering Bee is to alter the form of the assessment by groups to hope to decrease the defeats of the traditional tests and increase the features of the interactivity of the game-based learning. In the near future, the study plans to improve the feedback function to add more features into Answering Bee to make it more active and more fun. Furthermore, Answering Bee is not limited to English subject only, others subjects will be available. Besides, there are two aspects of the Answering Bee for the teachers and the learners. For the learners, this system will record their answering conditions in the database as to analyze their answering weaknesses as well to observe their learning achievements. For the teachers, teachers can realize what students have achieved and learned and then instruct the individualized learning according to each student's weakness and strengthens to motivate and achieve students' performance. Also, another system supplying teacher to add, delete and modify item bank on line will be constructed.

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# **Gender difference in social behavior change on a coop-competition game**

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## **Abstract**

Social cognitive theory indicates that social behavior of participants will change as they interact with others. Interaction in different social environment also results different change degree. The purpose of this study is to identify the social behavior of children during games play in a cooperative and competitive setting. A game named Strike up was developed for the study. The objective of the game is to advance arithmetic practice through five card number calculations and strategies. In order to realize the initiative behavior and change behavior during the game, participants' dialogues were video-taped and its content was later analyzed and interpreted by triangulation. The results of this study suggest that most players tended to express more egalitarian behavior than altruistic, dominating, or individualistic behavior at the beginning. Whereas, female players were more willing to mutually help each other. As playing time going and close to the goal, both boys and girls have more willingness to altruistic play. This implies this type of highly cooperation/ competition game will be a useful tool for children to experience egalitarian and altruistic behaviors.

Keywords: Game behavior; Social behavior change; Coop-competition game.

## **1. Introduction**

Social cognition changes appear to play an essential motivational role in game playing behaviors (Frey et al., 2005; Green & Rechis, 2006). Games children play generally influences social behavior (Green & Rechis, 2006; Milani, Osualdella, and Blasio (2009). Both antisocial behavior and prosaically behavior alike have important implications for social adjustments of children in game playing (Frey, Nolen, Edstrom & Hirschsten, 2005). During the game process, players would mutually help or display hostile behaviors to sustain their enjoyment during play. In game playing, individuals who attribute others' actions as hostile (rather than benign) tend to react with blame and anger when they are hurt (de Castro, Veerman, Koops, Bosch, & Monshouwer, 2002). To foster players' enjoyment, games should be developed in a community of caring through

cooperative learning (Donohue, Perry, & Weinstein, 2003), and sometimes generate hurting in the competitive situation. Under the cooperative/competitive situation, the caring or hostile behavior may occur which would ensure the interest of every player to continue to play or stop the game.

Most previous researches have focused on investigating novel forms of interaction to encourage collaboration, and techniques of gathering user for designing an enjoyment or playfulness games (Bekker et al., 2003). Wood, Williams, and McNeal (2006) suggest that increased complexity for children's expressed thinking is closely related to the types of behavior patterns interacting with differentiated change of community cultures. Moreover, Yee (2006) studies the model of player motivations in online games and suggests the gender relation to motivations, that reveals male players are higher on competition than females players. Following these excerpts, this study designs a mathematical game named "Strike up" for elementary school 6<sup>th</sup> grade students to play and to examine their social behavior change in different cooperative and competitive conditions. In line with this, the gender difference of interaction patterns related to the types of social behavior change from initiative to goal stages during game play would be identified.

## **2. Research Contents and Hypotheses**

Social Exchange Theory postulates that social behavior is about working toward maximizing one's own rewards and minimizing one's costs (Burgess & Huston, 1979). In time, individuals begin to rely on social exchanges and the future benefits or opportunities. Participants focus on reciprocity and operate under the norms of equivalence (Laursen & Hartup, 2002). For example, under the equity norm, each participant in a relationship should only receive as much as they give. If there is an imbalance, participants become distressed and work toward restoring equity (Walster, Traupmann, & Walster, 1978) whereas under the norm of equality, players are more concerned with the fair distribution of rewards, which are evaluated equivalent to individual input (Sprecher & Schwartz, 1994). Furthermore, cooperating with opponents can also be beneficial if they operate under the premise of reciprocal altruism – the tendency for an individual to help another only if he or she is helped in return (Sheese & Graziano, 2002). In other sense, the beliefs individuals have about other people's goals and intentions are important predictors of behavior in playing a game (Frey, et al., 2005).

Children may have different social goals across different contexts and choose to compete or cooperate for different reasons (Green & Rechis, 2006). Hammerstein and

Leimar (2006) referred to “conditional cooperation” as people tend to cooperate if their counterpart behaves in the same way. The efficacy of such reciprocity can be experienced by both parties’ social beliefs within relatively short periods of time. In the regard of social beliefs which affect social behavior pattern in playing game, Frey and his colleagues (2005) proposed four categories that reflect behaviors of game participants during decision making: (1) dominating behavior: whereby players select self-high outcome to dominate other members in a team or pair; (2) individualistic behavior: whereby players select self-high outcome to gain the greatest advantage; (3) egalitarian behavior: whereby players select equal-high outcome but self-high outcome is second choice; and (4) altruistic behavior: whereby players select equal-high outcome but self-low or equal-low outcome are second choices. To the current research, the conceptualization of Frey and his colleagues (2005) in regard to game participants’ behavior types is adopted as the condition of game change. In brief, game play is one kind of social learning (Bandura, 1986), in playing the game, social behavior can be changed along with the interaction increased. Then, hypothesis 1 can be postulated that *“Will the players’ socially competent behavioral change when they are grouped to play a coop-competition game?”*

## 2.2. Gender difference in social behavior change

Games vary in the ability of other players to reciprocate, the number of players, the number of iterations, the ability of outside observers to reward and punish selfish behavior, payoffs from cooperation versus defection, and the reputation of other players (Fehr & Fischbacher, 2003). They also differ in terms of stable individual differences of players, such as their age, sex, and culture (Henrich et al., 2005). With this form of social community, the proximate motivational and social dispositions that facilitate relationships and cooperative activities among boys and men should differ in some respects from those that facilitate relationships and cooperative activities among girls and women (Geary et al., 2003). By the elementary school years, there is an evidence to suggest that girls are more sensitive to any inequalities in their relationships and inequalities among females in general (Ahlgren & Johnson, 1979; Winstead, 1986). For instance, achievement of dominance in the peer group might in fact have both immediate and longer-term effects to both girl and boy’s social behavior (Geary et al., 2003). To be sure, there are evolutionary influences of sex differences in social behavior (Geary et al., 2003; Wrangham & Peterson, 1996), girls express more enjoyment in game playing (Lin, 2010). Then, in this study, the difference of behavior change between girls and boys in the game contest would be taken into consideration. Thus, the hypothesis 2 of this study can be postulated

as “*Is there any significant difference of behavior change between girls and boys in the game?*”

### 2.3. Game Design

In a broader sense, game theory is pertinent to virtually every dynamic interaction between sentient beings (Wilson, 2006). In line with this, several game rules have been developed to examine subjects' behavior in cooperative scenarios, which differ in complexity according to the number of participants and repetitions of social exchange. In a dynamic game design, the game scenario should provide players to constantly evaluate and adjust the competition/collaboration strategies, thereby engaging themselves in logical thinking (Kiili, 2005). Specifically, the developmental activities may enable girls and boys to form cohesive and competitive coalitions and thus work out in-group dominance relations (Geary et al., 2003) or with more series competition in game playing. To reiterate, the aim of the study is to investigate children's social behaviors displayed during the competitive situation, cooperation among participants is required. Thus, researchers developed an evolutionary computer based game, named *Strike Up*. In this game, six children were divided into two competing teams. The objective for each team is to move their flags from the start point to the end point (326 steps to the goal).

The numbers of steps to be taken at each round is relied on what was randomly drawn from the deck of virtual poker card shown on the screen. Five cards from 1 to 9 are retrieved by each player at each turn, and five card numbers can be used for counting the steps he or she can move. The five card numbers counting approach is limited to use +, −, ×, ÷ once in a turn. In order to move forward to win the game, the players have to calculate out the maximum value or best value to step forward. 10 J Q K cards are function cards perform *support* or *set up* functions. Children can use function cards to bonus points or to ‘tackle back’ other opponents (**Appendix 1**).

All participants can contribute positively because the game is designed in a way that children are encouraged to generate their own strategies. Children must take turns to ensure equal distribution of opportunities for each player. In concerning win the game for a team, three members (or all members in the team) should reach the end before the other teams. According to Richard et al. (2002) statement, if any of the teammates is lagging too much behind, giving punishment or bump back by other team members, in this scenario, competitive and cooperative behaviors are overt and are therefore easy to measure.

The other feature of this game design corresponds to Menasche and his colleagues' (2005) principles, which includes: (1) Games are played among teams; (2) Player interaction continues as time elapses; (3) Players can choose from different game modes; (4) Player decisions are associated with valuable movements; and (5) Players adjust game strategies according to game dynamics. The research tool *Strike Up* enables players to interact with content, collaborate with peers, and benefit from player support. It also allows players to decide on game rules and boundaries. Then, the game for this study can be considered as a strategy game with contest and constructive learning situation.

### **3. Experimental Design**

The research tool *Strike Up* is devised to elicit players' display of social behavior patterns as defined by Frey et al. (2005). This study uses evaluation checks to conduct observations and interpretations in order to examine behavior change of players. Analysis focuses on discourse analysis, students' transformative communication and behavior interpretation. Content logs were first created and it describes what happened during the course of video (Jordan & Henderson, 1995). Then, the patterns of emergent discourses were coded. That provided insight on how students' transformative communication occurred. The interaction patterns of social behavior was also observed and interpreted by using triangulation method.

This study includes six 6<sup>th</sup> grade elementary school students from a local elementary school in Taipei. They were divided into two teams. Three girls are in team A, they are labeled as A1, A2, and A3. The other three boys are in team B, they are labeled as B1, B2, and B3. The experiment was conducted after class hours. The participants played *Strike Up* as part of after class leisure activity. Three investigators were there to supervise, videotape, and to take field notes. To ensure validity of the study, three investigators read the data recorded from game playing by students to analyze and interpret the interactions among children. Each cooperation-competition scenarios were scrutinized.

#### **3.1. Data collection and analysis**

The contents of this game reflect the emphasis of on-line game. Then, the qualitative data can be carried out as exploratory work to identify themes for further exploration in a fuller study. Data analysis within interpretive methodology is complicated by the central assumptions analyzed by such researchers (Sandiford & Seymour, 2007). Miles and Huberman (1994, p. 9) suggested a variety of 'analytic practices' which could be summarized as: coding data, reflecting on data, sorting data, identifying patterns in data,

moving towards generalizations and developing or testing theories/conceptualizing (Sandiford & Seymour, 2007). Then, the process of analysis involves different stages as follows: 1) Preparation of data for analysis, 2) Coding and display, 3) Data reduction: Refining 'raw data' into clear text, 4) Componential analysis: Developing interpretations and verification, 5) Theme analysis: Developing interpretations and verification, and 6) Conclusion drawing.

In order to have a better reliability of data analysis, the triangulation method is applied in this study. Reliability has to do with the consistency or repeatability of assessments. Of the numerous types of reliability, estimating the internal consistency among items on an evaluation form and determining the number of responses needed to achieve precise evaluation ratings). Triangulation means an effort to define accurately the topic of study (Sim & Sharp, 1998), then, three investigators were there to supervise, videotape, and to take field notes. They read the data recorded from game playing by students to analyze and interpret the interactions among children. The reliability of data interpretation reached to .90 of this study, thus, those dialogues are based on the consensus from analyzing scenarios of the interaction

#### **4. The Findings**

Since children on the same team have varied understanding and expectations for interdependency. Individuals' coop-competition modes also differ. The observation was carried out for three rounds. Play sequence for one round constitute turn taking in the following order: A1-B1-A2-B2-A3-B3. Interactive dialogues in each round were classified into four types of social behaviors based on Frey et al. (2005) proposed theory.

##### **4.1. Dominating behavior in the game**

At the beginning of the game, the players with better arithmetic ability would figure out the value of the five number cards much sooner than those with lower arithmetic ability. Those players with better arithmetic ability would also spontaneously help those slow counting members and demonstrate some kind of dominating behavior.

**Situation 1:** To determine who to start first, the game was started by a game of "scissor, paper, and stone". It would be B1's turn to play but B2 stood beside and try to monitor B1's performance. An excerpt of the conversation is as follows.

B2 (speaks to B3) : "I hope you can draw out 9, 9, 9, and 9."  
B2 : "9, 9, 9, 1, 1... how wonderful !"  
B2 : " $9 \times (9+9)$ ."  
B3 : "Divided by 1, then minus by 1."  
B2 : "No, it should be minus by 1 then divided by 1."  
B2 : "Listen to me, you will find out that the value will be the biggest."  
B3 : "No, I insist on divide before subtracting."  
B2 : "It is the same, either way is OK."  
B3 : "But I prefer subtraction followed by division."(B2 tried to keep privilege)  
(13'25"~14'00")

B2's math ability is somehow better than B1's (according to the math tests). So, B2 have more confidence in counting and giving someone a hand. Then, it is observed that B2 is a dominating character who tries to enforce others to take his suggestions. The other type of dominating behavior occurred while approaching toward the end of the game Round 4).

**Situation 2:** It was B3's turn to play (The card numbers were 2,7,1,5,8. B1 tried  $2 \times (7 + 1 - 5) \div 8$ , yet he was hesitant, then B2 and B1 give some suggestions to him.

B3 : "6 divides by 8 is equal to?"  
B1 : "6 divides by 8 is equal to 6 out of 8."  
B2 : "No, the rules require us to round up, so the result is 0."  
B3 : "Is 0?"(B3 spoke in a doubtful sound.)  
B1 : "1 is goody !"  
B2 : "I count out , 1 or 0." (He stood up and insisted his results.)  
B3 : "Well, the result is..."(Ask B1 to confirm B2's results)  
B3 (speaks to B2) : "I don't want your help. I will count it by myself..."  
B1 (speaks to B3) : "You can take B2's idea. You can take B2's idea."  
B3 (speaks to B2) : "No, I don't want to listen to you."(B1 used left hand to keep B2 away)  
B2 (speaks to B3) : "OOXX" (Murmuring dirty words)  
B3 (speaks to B2) : "Go away or shut up !"  
B1 (speaks to B2) : "He counts out 1. Perfect !"  
B2 : "Really?"  
B3 : "Yes, it is right."  
B3 : "So, I can work it out by myself and do better than others."(Show that he is confident by tapping his chest using right hand)

(13'15"~14'35")

**Denotation:** People with a proself inclination are either self-maximizing or competitive and will only cooperate when it is in their self-interest to do so (Van Lange, 2000). People on Machiavellianism display a combination of selfishness and opportunism (e.g., Wilson, Near, & Miller, 1998). From the above discourse, B3 as dominator tends to cooperate less and their cooperative behavior is purely default.

#### 4.2. Individualistic behavior in the game

Those players with better arithmetic ability and more ambition in winning the game will show that they only concerned about themselves in counting or using functional cards.

**Situation 1:** It was B1's turn in the secondary round. B1 was counting his five cards to figure out the maximum value or best value (go by short) and B2 drew another five cards to count (A3 will be next player).

B1 (speaks to B2): "I have 6, 7,8,3,7, how to arrange for best movement."(B1 tries to ask for B2's assistance)

B2: "6,7,8,3,7.....Very good. But, I have 6,2,5,7,6. I have to figure out the best value."

B1 (speaks to B2): "Please help me figure out this first, it is my turn to move."

B2: "Let me figure out mine, then I will count for you."

B1: "The scenario will be changed after this turn, the value you count out will be useless, please count mine first."

B2: "No, after I figure out mine, I will count for you."

B1: "You help me, then, I will help you."

B2: "I count out mine already, now I can help you."

(18'25"~23'00")

**Situation 2:** B2 played his turn by figuring out the best value of five cards. After moving his flag to that place which according to the calculation of the five card numbers, he drew the so called "function card" and got J card by which he can move forward 50 steps as bonus or give to one of his teammates to move forward 50 steps. Since B3 was lagging way behind and he wished that B2 could give him a hand.

B3: "B2 please use that card for me, I am so far behind everybody else."

B2 (making an excuse): "I want that card for myself. Do not be worried; you will get a lucky card during your turn."

B3: "You should help me; otherwise we will lose the game."

B2: "Don't worry; it is still very far from reaching the end. I would have helped you if I am close to the end."

B3: "... I might always be kicked back, then, it will be too late to rescue me later."

B2: "You are too noisy. I will wait for someone to give me a hand, and then I will help you."

(25' 25" – 28' 40")

In order to promote the playfulness in the mathematic game, the cooperation and competition are two very important elements. If the players only approach the game competitively, then it will be very difficult for all members to finish the game. In particular, at the very final stage, the exact value needs to be figured out for the rest steps to the goal, if there are the remaining values after subtracting the steps to the goal, the player will move him or her further backward from where he or she started. Thus, players should realize that cooperation is important as the team needs to win the game together.

**Situation 3:** As the game went on, most players were having their flags close to the end. This meant that the chance of being bumped back would be increased. In addition, the function card could be used to help others and/or hinder others. If team members were too individualistic, it would be difficult to finish the game.

B2: "I got bumped back so many times; I stayed around the last part of the game for at least 10 minutes."

B3: "You deserved it."

B1: "B2 you should help B3 at the beginning of the game."

B2: "OK. I know I was wrong."

(14' 00"-14' 10")

**Denotation:** Individualisms showed that their social strategies are more calculative and adapted to the situation at hand. It is not unlikely that behavior should predominate among individuals with other-regarding preferences (Bogaert, Boone, & Declerck, 2008; Gintis et al., 2003). In line with this, the above discourse indicated that B2 cooperation in a social dilemma was more likely to proself before he can help others. B2's willingness to cooperate in one-shot social dilemmas has further been related to individualism in stable personality traits.

#### 4.3. Egalitarian behavior in the game

At the beginning of the game, opposing teams sought possible assistance by exchanging

benefits. However, it was uncertain if the other members could be trusted. Exploratory talks were frequently conducted to test each other and to determine whether the other team could be trusted. Mutual improvements were pursued throughout the process with optimistic attitude.

**Situation 1:** A1 believed that the game was just a game. She did not take it too serious but still tried to seek reciprocally help. At the beginning of game, she ever gave some benefits to B2. It was interesting that one of her teammates (A2) tried to compete to hurt one of opposite teammates, so when A1 got a number, she can decide t to bump back B2 or recalculate out other number to move forward, A2 asked her to take the first action to bump back B2.

A2: "Try to bump back B2."

A1 : "Never mind, I will give way to B2, he will repay me later!"

B2 : "A2 (Calling her by the name) I will revenge, watch out!"

A1 : "Just remember to add 90 steps for me!"

B2 : "No way, your friend did this to you, blame her."

B1 : "If we get a King, we will set her (A2) up"

.....

A1 : "Your thoughts are evil!"

B1 : "You call me evil! B2 is worse than me!"

A1 : "But I just descended him and revenged!"

It is the turn of B2 to draw the function card, and he got the King card.

B2 : "K, according to the rules of this game, I will move A2 50 steps backward."

A2 : "Please help me, don' hurt me. You can use it to help your teammate B1"

B2 : "Ok. I will let you know what revenge is" (B2 set A2 to move backward 50 steps)  
(39'40~43'30)

By Round 3, there were more descend short-cut close to the target. The possibility of setting up rivals using function cards increased. The desire for the children to win resulted in attitude inconsistencies and conflicts. Different strategies to handle conflicts reflected the individuals' varied characteristics. It was even possible for the members to alter individual social behaviors in order to solve the conflicts.

**Situation 2:** In the scenario below, A1 and B1 insisted on keeping promises (Egalitarian) at the beginning of the game. However since B3 wished to win, his attitude was more individualistic at this stage. A1 was displeased and B1 tried to change the mind of his teammate. In the process, B3 altered his social behavior.

B3 : "J, according to the rules of this game, I got J, I can assign one opponent to the

nearest ladder to go up or descend.” (B3 assigned A1 to descend.)

B1 : “Really?” (His teammate was surprised in B3’s decision)

B3 : “Why not?”

B1 : “Didn’t A1 just descend a while ago?”

B3 : “Why can’t she (A1) be moved down again?”

A1 : “Why did you descend me again?”

B3 : “Why should I be nice to you? You’d better go down from here.”

B2 : “Oh, let them both go down, so I can get rid of them both!”

A1 : “B3, you shouldn’t do that.”

B3 : “I’d do anything to win, so I don’t really want you to go up.”

A1 : “All right then, you owe me 3 square magnets! It’s unfair! You broke your promise! You will be condemned by God!”

B3 : “I honestly want A2 to descend some more, but I can’t.” (A2 is closed to the end)

A1 : “Never mind just let her go up. It gets harder the closer she gets.” (The rule of this game require the players to find the right numbers to step forward to the end, otherwise, the players have to move backward based on the rest of numbers deducing from the forward steps)

B3 : “Ok! I will let A2 go up.” ◦

(Meanwhile, B1 interrupted their conversation and ask B3 to help A1)

B1: “Look! B3 let you go up!”

A1 : “Ok, then. We are even B3!

( 53’15”~55’50”)

**Denotation:** Not surprisingly, the term “strong reciprocator,” commonly used by Egalitarian, refers to those individuals that are inclined to both cooperate in one-shot interactions, and support those who do (Fehr & Fischbacher, 2004). From the above discourse, the study indicated that A1 is a strong reciprocator even willing to help a defector when they themselves were merely the opposite party of a fair interaction.

#### 4.4. Altruistic behavior in the game

In a game, not all people share common interests and help one another strategically. In a group, there are those who do not expect returns. After multiple “gives”, a positive stimulus is produced within the group. Subsequent mutual help and teamwork attitude are then produced. Based on observed records, A2 is the altruist. The dialogue below shows how she repeatedly assisted her teammates in conducting computations:

**Situation 1:** At the game, basically, nobody can use calculator to count his or her number cards. Not every participant is good at arithmetic. Those who did better at math would need to wait longer for his or her turn and might feel impatient. As such, it was observed that effort was made to help those who were poor at arithmetic, even for the opponents.

A3: "B3, what cards have you got?"

B3: "8, 9, 3, 8, 1..."

A3: "let me count, 8, 9, 3, 8, 1..."

B2: You can't calculate for the opponents."

A3: "Yes, I can."

(73'23"- 75'15")

Toward the last part of the dialogue during the game, A3 actively helped others but was not dominating. She sought the greatest benefits by calculating on behalf of others.

**Situation 2:** Also, A2 displayed "self-sacrifice" characteristics in the group. She sacrificed herself to achieve greater good for the group. It is A1's turn, A2 asked others to descend her as shown in the dialogue below:

A1 : "Let's calculate together (referring to A3), and see who's better."

B3 : "You can't help her calculate!"

A2 : "Let's compare if the equation she just wrote is better than mine."

(76'20"~76'53")

A2 : "I descended the least, descend me please." (She tried to work out the most possible ways to get the end for other teammates)

A1 : "Why do we descend all the time in the game"? (She seemed to ask all players to give helps to opponents instead of giving hurt)

(77'00"~77'10")

Toward the end of the game, A2 and A3 even helped their opponents compute. The mutual help mode not only applied among teammates but also between opposing teams.

**Situation 3:** At the final stage, if players choose not to use negative strategy, due to it was likely that all members of the team would be descended. Then, it would be difficult to get to the end.

A3 : "B3, my calculations turn out to be 16."

A2 : "16 means B3 has to go back a long way, 12 steps will be better."

A3 : "B3 wait a moment, I re-calculate and come up to 10, take a look for you!"

(90'05"~90'30")

**Denotation:** After being treated fairly and unfairly in a cooperative/competitive game, altruistic express cooperative emotions more frequently than do dominators or individuals (Schug et al., 2010). From the above discourse, that is, by expressing help emotions in the game playing, A2 and A3 are altruistic cooperators reveal their honest motivational intentions which serve to attract potential interaction partners and deter defection.

## 5. Discussion and Conclusion

Social behavior changes refer to the phenomena that people seem to care about certain “social” goals, such as a “fair” allocation among members in society, in addition to their own material benefits (Li, 2008).

To answer the first research question: “*Will the players’ socially competent behavioral change when they are grouped to play a coop-competition game?*” The results of this study showed that at the beginning, individualistic behavior displayed frequently in the boys’ team and dominating behavior was displayed at the final stage in the boys’ team. Evidence of ‘conditional cooperation’ is identified: when students expect others to contribute, they themselves tend to donate more (Frey & Meier, 2004). In the manifestations of children’s game behavior, the interaction frequency increases as they get closer to the target, their altruistic behavior appeared at the final competitive stage in female team. The Strike Up game involved activities in creating coalitions and dominance result in many of the social behaviors of boys that are sometimes viewed unfavorably, this result is agreed to the study of Geary et al. (2003) which indicates that boy are more serious to win then their proself behavior is displayed at the beginning stage of competition, because they do not want to be the suckers (Croson, 2007; Gächter et al., 2003)

To answer the second research question: “*Is there any significant difference of behavior change between girls and boys in the game?*” It is observed that the numbered cards utilized in Strike Up help promote arithmetic competence of children. Function card use also helps enhance interactions between teams. The function cards in the game design can be used to help or to set up opponents. At the beginning of the game, girls mostly interacted in egalitarian mode, or chose to be outsiders. When competition grew fiercer at the end of the game, children changed from egalitarian to individualistic or altruistic. If an altruist is present in a group such as A2, there will be mutual help between groups, and harmony can be maintained. The results are agreed to the studies of Geary et al. (2003) and Trivers (1971) which state that among the proximate mechanisms of cooperation,

if they feel guilt for a failure to reciprocate, they will monitor the give-and-take of the relationship and maintain the cooperation. In comparison to girls, the relationships of boys are predicted to be and are more readily maintainable (Whitesell & Harter, 1996).

In conclusion, this study found that apart from a few unconditional cooperators (“altruists”), most 5<sup>th</sup> grade male students are *only* willing to cooperate when they expect others to cooperate as well. The most powerful support for the importance of social norms for altruistic behavior directed towards genetically unrelated individuals stems from studies of strong reciprocity. Consequently, people who contribute apparently trust the others after several runs in this game. These results of this study may imply grouping system for allocating different characters of students in the game of *Strike up* to promote the awareness of prosocial behavior and maintain the behavioral intention more stable.

## **6. Limitation and Future study**

This study has been conducted in qualitative method, the case analysis was employed which might not be enough to predict all other cooperative and competitive contest settings, and the quantitative method should further be applied to analyze the research data to imply the better grouping for students to have behavior change.

Social information processing models can be used to explain the development and maintenance of prosocial behavior (Nelson & Crick, 1999). More precisely, relationships based on reciprocal altruism should result in the evolution of proximate social and emotional mechanisms that function to ensure equality of the benefits received from the relationship. This model would be examined in relation to the development of behavioral intention, future study may place at examining the relation between prosocial behaviors and the evolutionary change of 4 types of game behavior in a coop-competitive game.

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## **Appendix 1: The objectives and rules of Strike up game**

### **A Objectives of the game**

1. To improve the four arithmetic operation abilities in players
2. To foster group unity and highlight team work
3. To encourage long-term planning with the design of elevators, for example. Students learned that what seems to be a shortcut may be a trap in disguise.
4. To enhance teachers' understanding of students' personality—may they be conservative or aggressive players— with the design of Safety Area.
5. To train students in making decisions with optimized game strategies.
6. To increase difficulty in using four arithmetic symbols with five Number Cards instead of four.

### **B Basic game rules**

1. The game is played between two teams: Team A and Team B. Each team is composed of 2-3 members, coded as A1-A3 and B1-B3.
2. Every player begins from the *Start*. Players take turns drawing cards in the order of A1 → B1 → A2 → B2, and so on.
4. Player first draw designed *Number Cards* (1 to 9), and create a math equation with these numbers in addition to math symbols including *addition*, *subtraction*,

*multiplication, division, and parenthesis.*

5. Each symbol can only be used once.
6. Then players round up the number they come up with at this stage before continuing with the calculation and move to that position.
7. Next, players draw one Function Card (10, J, Q, K, and Joker) and calculate accordingly to reveal with the final number of steps for them to take.
8. The process repeats with every player.

### **C Player advancement**

1. *Shortcut*: players must take any elevator they happen to encounter on their way to the finish. Elevators may be going upward or downward depending on game design.
2. *Bumping back*:
  - 2.1. players from opposing teams may find themselves in close proximity to each other during the game.
  - 2.2. When a *late comer* approaches to within 5 steps from an *early arriver*, the early arriver would be *bumped off* its leading position and relocated to the late arriver's previous position.
  - 2.3. This rule does not apply to situations where the late comer approaches by using a Function Card or a shortcut.
3. *Safety Area*: when players stop in a *safety area*, they are exempted from losing their leading position when a late comer catches up.

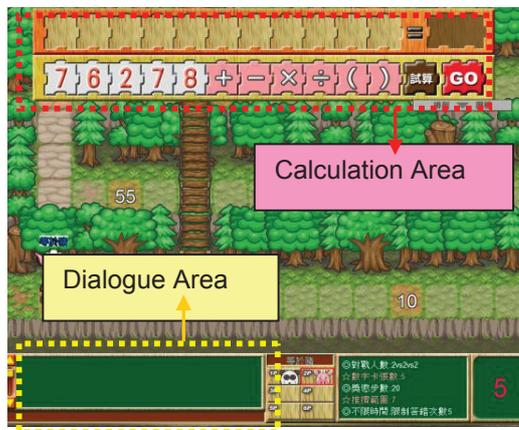
### **D Function Cards**

1. *10*: Take the nearest elevator to move yourself up or down regardless of where it goes.
2. *J*: Make one player take the nearest elevator to move up or down
3. *Q*: Go 50 steps forward or backward for yourself.
4. *K*: Make one player go 50 steps forward or backward.
5. *Joker*: The player is suspended from the game for the next round.

### **E Condition for winning**

A team is considered the winning team only when every team member arrives at the finish. Players have to stop exactly at the finish for them to conclude the game.

## **Appendix 2: The Scene of Strike up game**



## **Gender Differences in Help-Seeking and Supportive Dialogue during On-line Game**

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### **Abstract**

Gender difference plays an important role of helping-seeking and supportive behavior while the players encounter win or lose situation that will affect the cooperation in the on-line game. Our research team developed a game called Strike Up, and used it to investigate the help-seeking and supportive behaviors displayed by children in the cooperative/competitive scenarios. In Strike Up, players must calculate numbers in a strategic fashion so that they can move their flags to the destination faster than their opponents. Game players' help seeking and supportive types in on-line discussion were categorized by Kappa method and data was analyzed by Kappa method, then Chi-square test was employed to examine the gender difference in different types of dialogues. The discourse analysis indicated that boys exhibited used more negative semantics. Girls appeared to display a more communal or cooperative orientation, as they used more positive, socially supported language. At the beginning of the game, boy were less willing to seek help than girls, yet, at the end, as the pressure of the competition mounted, male players became more eager to find assistance from teammates and were seen to adopt more help-seeking behaviors. The results can be implicated to increase the competition in game design to foster the help-seeking and supportive social behavior.

**Keywords:** Gender differences, Help-seeking, Social support, Discourse analysis, Interactive behavior.

### **Introduction**

Social constructionists contend that knowledge is developed and sustained through social processes, and knowledge and social actions are intricately linked. Berge and Colins (1995) point out the following: "Talk and discussion provide an opportunity to articulate and explain one's own thing and perhaps to modify one's own ideas, beliefs or self-presentation in response to feedback from others. Incorporation of new data, the testing of arguments, and using one's judgment and reasoning helps move a person toward new perspectives and higher levels of thinking" (p. 183). Weinberger, Stegmann and Fisher (2007) have focused on the acquisition of knowledge and the idea that learners may share knowledge by contributing their ideas through discourse (knowledge sharing),

and that other learners integrate these ideas into their own lines of reasoning. Fraser et al. (2005) proposed that social–emotional skills, which involve information processing skills, enhance confidence in one’s social skills. It is suggested that playfulness can be enhanced during mathematical games to improve social skills, especially when one seeks to show colleagues the mechanisms of problem solving (Nunokawa & Fukuzawa, 2002; Hanna, 1995). Situations in which colleagues offer reciprocal support in an effort to find possible solutions to a problem will promote their interest in game playing (Nunokawa, 2005). There is some evidence that collaborative discourse and argumentation make learning gains more permanent (Nussbaum, 2008). In line with those excerpts, help-seeking plays an essential role particularly important in computer-based interactive learning environments (Bartholomé, Stahl, Pieschl, & Bromme, 2006), this study generate a game named Strike up which needs the players involve in a cooperative and competitive situation to test their social emotion change.

Research on gender differences in computer game playing suggests that boys have historically been seen as more successful (Greenfield, 1999) and enthusiastic (Mitchell, 1985) than girls, particularly in competitive game play. Carbonaro, Szafró, Cutumisu, and Schaeffer (2010) use an interactive game adventure authoring tool to measure gender difference and find that females scored significantly better than males on higher-order thinking skills. From social cognitive psychology, gender differences appear to be important in help-seeking and support behaviors (Wester et al., 2007). To date most research on help-seeking is restricted to e-learning settings. Due to essential differences between the help-seeking process in e-learning interactive settings and in cooperative-competitive game of these findings would be inappropriate. Thus, there is a need to conduct research on help-seeking in the cooperative-competitive game as an understanding in its own right. As such, this study investigates gender differences in educational game play through exploring following two questions: 1) the different types of help-seeking and supportive behaviors of boys and girls, and 2) the changes in help-seeking and supportive behavior as play proceeds.

### **Research Contents and Hypotheses**

Vygotsky emphasized dialogue. He argued that all cognitive functions originate in social interactions, and that learning is not simply the assimilation and accommodation of new knowledge by learners (Fosnot & Perry, 2005; Vygotsky, 1978). From his perspective, creating meaning involves a process of sharing various perspectives and

experiences in communities of practice (Fosnot & Perry, 2005; Vygotsky, 1978). Therefore, learning is derived from rich conversation with other people who have similar or different perspectives based on their own life experiences (Jonassen, 1999).

### 1. Help-seeking and support in game playing

In Vygotsky's socio-cultural view, mental functioning develops as the learner internalizes and transforms the contents of social interaction (Vygotsky, 1978b, 1981). From a coactive systems viewpoint, individual action emerges as the product of coactions among components, and is not the linear outcome of components acting independently (Mascolo, 2005). Therefore, in coactive game playing, mutual benefits are maximized as learners work together to complete common tasks in a supportive, reduced-stress climate. Thus, learning partners have played an important role in previous interventions that incorporated learning through playing (Homles, 2007). Shih (2007) studied the avoidance of help-seeking in upper elementary school students, and observed that if the goal structure was very clear to the students, more adaptive help-seeking tendencies would be displayed. Nevertheless, from a psychological point of view, a partner's unwillingness to share information with others in social interactions is hardly surprising, given that the transmission of information is often regarded as a loss of power (Kimmerle, Cress, & Hesse, 2007). In addition, giving information is associated with extra time and additional effort. Specifically, it is suggested that the exchange of explanations about strategies learned will increase the level of student interest in the content (Webb & Mastergeorge, 2003). To understanding the willingness to help-seeking or supportive from players' dialogues at different stages, the hypothesis to guide this study is:

**Hypothesis 1:** Players' would have more willingness to seek help and support others while they encounter highly competitive stage.

### 2. Gender difference in help seeking and supportive game behavior

Under cooperative conditions in game playing, group members will help each other to some extent in rearing and guarding the player mates (Pen & Weissing, 2000; Weibull & Salomonsson, 2006). Some evidence suggests that boys are much more enthusiastic in computer game than females (Connolly, Boyle, Stansfield, & Hainey, 2007; Gorriz & Medina, 2002). In addition, boys' speech is often directive, and is frequently used to assert power and influence over others (Archer, 1992; MaCcobly, 1998). In contrast, girls tend to engage in more intimate social interactions, turn-taking, and cooperative endeavors (Meece, Glienke, & Burg, 2006). Taken together, boys have been characterized

as having a more competitive style of interaction, while girls have a more communal or cooperative orientation (Eagly, 1987; Hartmann & Klimmt, 2006; Leaper, 1994). However, it is also important to note that there are many instances in which girls and boys behave similarly (Underwood, 2004). As those different assertions, the research hypothesis to guide this study is:

**Hypothesis 2:** Female players would have more willingness to seek helps and support others than those male players.

## Game Design

Collaboration has been shown to increase students' knowledge of a wide range of subjects, including biology (Lazarowitz & Karsenty, 1990), mathematics (Fuchs et al., 1997; Webb, 1991), narrative composition (Daiute & Dalton, 1993), and computer programming (Web, Ender, & Lewis, 1986). Based on affordance theory (Gibson, 1977), this study was designed to examine the information-exchange dilemma between game players. Therefore, the game design for this research to analyze players' contribution behaviors represents a particularly stringent test of tools that foster computer-supported cooperation and competition.

To investigate children's behaviors in a competitive situation, a new game that requires cooperation among participants was developed as a research tool for this study. The game Strike Up was adapted from WEST, which was originally developed at the University of Illinois and subsequently revised, based on *Game Design Principles* by Kiiili (2005), to increase player engagement. Although the essential elements in WEST were kept intact, some alterations were made to adapt the game for use in this study. The learning theme was changed to four arithmetic operations. In Strike Up, students must calculate numbers to move their flags to the game journey's destination. In the game's competitive mode, players of Strike Up have two choices of mode, 2 vs. 2 or 3 vs. 3. The children must take turns to ensure equal distribution of opportunities for each player. All participants can contribute positively, because the game is designed for children to generate their own strategies according to the rules of game.

Dice were replaced with playing cards (1-9), plus bonus cards (10, J, Q, K) that perform killer functions to increase game complexity. Each card dictates different game conditions. Number Cards are used to indicate numbers used in arithmetic operations,

while certain cards are designated as special Function Cards. Some cards limit or increase players' use of four mathematical symbols (+; -; ×; ÷). For example, mathematical parentheses “( )” may be added to adjust game complexity for different players. In terms of game difficulty, the original bumping range was enlarged from 0 to 5 to increase the opportunity of being bumped back and the difficulty of arriving at the destination (Figure 1). In this scenario, based on students' dialogue, competitive and cooperative behaviors are overt and therefore easy to measure.

Strike Up is an internet-based game. Students can enter the game environment by connecting at home or by going online elsewhere. Besides playing the game, players can also interact with other players by entering design dialogue areas, as depicted in Fig 1.



Fig.1 The Strike Up game scene

## Research Design

Social constructionists recognize that meaning is constructed through language in context, and this is of particular relevance to this study. Attention to language is the social constructionists' acknowledgement of the significance of discourse (Young & Collin, 2004). Discourse advances thinking and is central to the process of knowledge construction. As ideas are shared and assessed, feedback is received and interpreted, emerging problems are solved, and joint decisions are made (Hennessy & Murphy, 1999). Cognitive presence represents the analysis, construction, and confirmation of meaning and understanding within a community of learners through sustained discourse (Garrison & Anderson, 2003). Through discourse, ideas, solutions, and decisions are made explicit and visible; partners share information and plan together, and engage in joint reasoning, evaluation and decision-making (Mercer, 1995).

Studies have found that different types of verbal interaction support different types of learning (Cohen, 1994). The resulting protocols that guide interaction are briefly discussed below. Discourse is characterized as messages about other messages (de Souza, 2005). Discourse is a process whereby interlocutors explore existing signification artifacts in order to express what they mean (de Souza, 2005). According to Osgood’s classification (Osgood & Tanaha, 1965 ; Osgood, May, & Miron, 1975), language meanings can be grouped into three types: evaluation, potency and activity. Evaluation messages (‘good–bad’) are related to the judgment of abilities, for example, “you are very smart” or “you are very lousy.” Potency messages (‘strong–weak’) are related to inspiration or discouragement, for example, “you are close to working it out.” Activity messages (‘do–undo’) are related to instructions for doing more or thinking more, for example, “you can try it again.”

The study involved playing Strike Up as a competition. The participants in this study were students from three schools. Each school sent twelve students, and students from the same schools were organized into three teams, based on gender. During the competition, verbal communication was forbidden. All communication had to be carried out through the embedded dialogue facility. The game dialogue and processes were recorded, and were subsequently examined for gender differences in the conversation content and cooperation modes. According to the theoretical framework below, this study classified the cooperation modes into Tables 1 and 2 (See Tables 1 and 2).

The connotative meaning of words can be reduced in dimension by factor analytic procedures. Principal component analysis of the students’ dialogue extracted three components, which corresponded to the Evaluation, Potency, and Activity dimensions of Osgood and Tanaka (1965) and Osgood et al. (1975). The present study used a content analysis method to analyze children’s conversations during the game. After classification of their conversations, a quantitative analysis was conducted. Differences in play based on gender were explored through six discourse types (Table 1).

Table 1: The different types of help-seeking and supportive dialogue

|                                   |                 |                 |                   |                 |                 |                 |
|-----------------------------------|-----------------|-----------------|-------------------|-----------------|-----------------|-----------------|
| Semantics<br>Interactive behavior | <b>Activity</b> |                 | <b>Evaluation</b> |                 | <b>Potency</b>  |                 |
|                                   | <b>Positive</b> | <b>Negative</b> | <b>Positive</b>   | <b>Negative</b> | <b>Positive</b> | <b>Negative</b> |

|                     |            |            |            |            |            |            |
|---------------------|------------|------------|------------|------------|------------|------------|
| <b>Help-seeking</b> | <b>1.1</b> | <b>1.2</b> | <b>3.1</b> | <b>3.2</b> | <b>5.1</b> | <b>5.2</b> |
| <b>Supportive</b>   | <b>2.1</b> | <b>2.2</b> | <b>4.1</b> | <b>4.2</b> | <b>6.1</b> | <b>6.2</b> |

Table 2: The classification categories and examples of help-seeking and supportive dialogue

| Semantics         |     | Content                      | Examples   |
|-------------------|-----|------------------------------|--|
| <b>Activity</b>   | 1.1 | <b>Positive Help-seeking</b> | Directly request assistance<br>Help me.<br>Help me count.  |
|                   | 1.2 | <b>Negative Help-seeking</b> | Use provocative words<br>Are you able to figure that out for me?   |
|                   | 2.1 | <b>Positive Supportive</b>   | Directly provide assistance<br>$(9-6)/1*2+1$<br>$(8+4)*8-1/2$<br>Look carefully at where the steps of the short-cut derive the bigger sum.             |
|                   | 2.2 | <b>Negative Supportive</b>   | Use challenging words<br>Why can't you do addition and subtraction before multiplication and division?<br>If you count it wrong again, I will hit you. |
| <b>Evaluation</b> | 3.1 | <b>Positive Help-seeking</b> | Use praise to gain assistance<br>Your mathematical ability is the best.  |
|                   | 3.2 | <b>Negative Help-seeking</b> | Use self-criticism to gain assistance<br>I am lousy at math, or, I am stupid.  |
|                   | 4.1 | <b>Positive Supportive</b>   | Use praise to provide less assistance<br>You are great; I only have to tell you a little for you to figure it all out.                                 |
|                   | 4.2 | <b>Negative Supportive</b>   | Use negative criticism to provide less assistance<br>You can't figure it out. I really want to   |

|                |     |                              |  |   |
|----------------|-----|------------------------------|--|---|
|                |     |                              |  | scold you (stupid!).  |
| <b>Potency</b> | 5.1 | <b>Positive Help-seeking</b> | Express confidence by using self-assertive words | This question is so easy for me to count.   |
|                | 5.2 | <b>Negative Help-seeking</b> | Use discouraging and/or unfortunate words        | This one is difficult. My card no. is very low.   |
|                | 6.1 | <b>Positive Supportive</b>   | Use encouraging and/or motivational words        | Keep going, the right answer is very close.   |
|                | 6.2 | <b>Negative Supportive</b>   | Use discouraging and/or unfortunate words        | Hurry up! There is no time for you to count. You got bad luck. You really are a joker's sister. |

## 2. Data collection and analysis

In this sense, social support can be defined by the perception of support. These concepts are best measured by observations and reports, by indices of satisfaction, or by scores of perceived support (van Dam et al., 2005). Interpretive discourse analysis (developed from the perspective of an insider) can be used to explore issues (e.g., those relating to role extension) implicit in texts arising from computer data mining, interviews, diary notes, questionnaires, institutional documents, and throughout the literature. Data are subjected to analysis at various stages in the research process. The processes of transcription and participant checking constitute further acts of interpretation. More formal analysis involves deliberately engaging in the act of interpretation and making sense purposefully through the exploration of themes and discourse in various categories (Boyes, 2004). Help-seeking and support related to game playing are accomplished through language. Approaches to language and textual analysis take many forms, and are closely related to issues of representation. To collect conversational data during game playing, students must type their thoughts in the “dialogue area.” This text can then provide the data for discourse analysis.

A content analysis research method was used in this study. Before the analysis, all players' dialogue was stored in the computer game, which provided a large amount of dialogue data to be analyzed. Content analyses were focused on the following: (1)

semantics; (2) the relationship between gender and semantics; (3) interactive behavior; (4) the relationship between gender and interactive behavior; (5) the relationship between time and semantics; and, (6) the relationship between time and interactive behavior. In order to obtain consistency between the analyzers, the Kappa method was applied to examine the coefficient of discourse sentence analysis (Fleiss, 1971). The resultant kappa value was .709, which indicated that the analysis of the two focus groups (4 members in each group) reached significant consistency. Thus, all discourse could be classified into the 12 categories shown in Table 1.

### **Research findings**

Data from 36 participants was collected in the Strike Up game. Researchers used a total of 382 sector dialogues. Their contents were analyzed according to the three dimensions: semantic activity, evaluation, and potency. Furthermore, each classification was divided into help-seeking and supportive interactive modes, and was encoded by positive and negative valences. The researchers also observed whether there were any changes in dialogue content as play time increased. Because the game was run three times and took a total of 75 minutes, the timeframe of analysis was divided to three 25-minute segments to check whether there were semantic changes as the game proceeded. The results of this study are illustrated as follows:

#### **1. Semantic use in general**

Through the analysis of gender and semantic frequency cross-reference (see Table 3), the category of positive supportive activity was found to have the highest frequency (23.6%). Examples of this category are: “Look carefully at where the stairs are,” “Look carefully!” or “ $8+4*8-1/2=39.5$ ” (direct formula). These are the statements that demonstrate direct assistance or are more directive-oriented. The second-highest frequency rate, 20.9%, was in the category of positive supportive potency. The statements that exemplified this type were encouraging words such as “Keep going!” Finally, 15.7% of the overall statements were classified as a positive help-seeking activity, which demonstrated direct assistance seeking.

Each of these three types was positive. Overall, 67% of the statements showed a positive tone. This result demonstrates that the participants in this study tended to construct linguistic expressions filled with positive encouragement and assistance.

## 2. Gender differences in semantic usage

There were significant differences in semantics between the two genders ( $\chi^2 = 19.706, p < .05$ ). Table 3 shows that the proportion of statements in the categories of positive and negative supportive potency, were higher in girls than in boys. This suggests that girls tended to express encouraging types of words, such as “Go” or “Hurry up,” more than boys did. Boys had a slightly higher frequency of negative supportive evaluation wording than the girls. This suggests that boys tend to use “You are stupid” types of sentences more frequently. Statements classified as positive supportive evaluation were not observed in this study. This means that neither boys nor girls in this study said anything that could be classified as praising another’s abilities.

Table 3: The percentage in each classification by gender

| Classification |                   |          | Girl  |      | Boy   |      | Total |      |
|----------------|-------------------|----------|-------|------|-------|------|-------|------|
| Semantics      | Interactive model | Trend    | Count | %    | Count | %    | Count | %    |
| Activity       | Help-seeking      | Positive | 33    | 8.6  | 27    | 7.1  | 60    | 15.7 |
|                |                   | Negative | 2     | 0.5  | 2     | 0.5  | 4     | 1    |
|                | Supportive        | Positive | 37    | 9.7  | 53    | 13.9 | 90    | 23.6 |
|                |                   | Negative | 6     | 1.6  | 8     | 2.1  | 14    | 3.7  |
| Evaluation     | Help-seeking      | Positive | 5     | 1.3  | 2     | 0.5  | 7     | 1.8  |
|                |                   | Negative | 4     | 1    | 6     | 1.6  | 10    | 2.6  |
|                | Supportive        | Positive | 0     | 0    | 0     | 0    | 0     | 0    |
|                |                   | Negative | 7     | 1.8  | 18    | 4.7  | 25    | 6.5  |
| Potency        | Help-seeking      | Positive | 9     | 2.4  | 10    | 2.6  | 19    | 5.0  |
|                |                   | Negative | 26    | 6.8  | 17    | 4.5  | 43    | 11.3 |
|                | Supportive        | Positive | 48    | 12.6 | 32    | 8.4  | 80    | 20.9 |
|                |                   | Negative | 21    | 5.5  | 9     | 2.4  | 30    | 7.9  |
| Total          |                   |          | 198   | 51.8 | 184   | 48.2 | 382   | 100  |

## 3. Interactive behavior in general

Overall, the percentage of interactive behaviors providing assistance (62.6%) was higher than those seeking assistance (37.4%). This demonstrated that the children in this study tended to offer help more often than they asked for help.

## 4. Gender differences in interactive behavior

There were no statistically significant differences in interactive behavior between

girls and boys ( $\chi^2 = 1.066, p = .302$ ). As shown in Table 4, the percentages of supportive and help-seeking dialogue were very similar between girls and boys.

Table 4: The percentages of interactive behavior by gender

| Interactive Behavior | Girl  |      | Boy   |      | Total |       |
|----------------------|-------|------|-------|------|-------|-------|
|                      | Count | %    | Count | %    | Count | %     |
| Help-seeking         | 79    | 20.7 | 64    | 16.8 | 143   | 37.4  |
| Supportive           | 119   | 31.2 | 120   | 31.4 | 239   | 62.6  |
| Total                | 198   | 51.8 | 184   | 48.2 | 382   | 100.0 |

### 5. Semantic changes over time

The time frame for analysis was divided into three periods, each of which lasted for 25 minutes. The interactive dialogue between the players was recorded in the system. The results of Chi-square testing revealed that there were no significant differences in semantics among the three time periods ( $\chi^2 = 43.261, p < .05$ ). As shown in Table 5, greater amounts of dialogue were recorded in the first and second periods (counts of 128 and 161, respectively) than in the third period (93). This trend was observed in most of the semantics classifications. The exception was in positive supportive words, where the first time period had a lower count than the second and the third time periods, with a ratio of 17.2/25.5/29.0. This means that direct assistance seeking increased towards the middle and end of the game.

Table 5: The percentages of each semantic classification by time period

| Classification | Semantics    | Interactive model | Tendency | First section |     | Second section |     | Third section |      |
|----------------|--------------|-------------------|----------|---------------|-----|----------------|-----|---------------|------|
|                |              |                   |          | Count         | %   | Count          | %   | Count         | %    |
| Activity       | Help-seeking |                   | Positive | 7             | 5.5 | 29             | 18  | 24            | 25.8 |
|                |              |                   | Negative | 2             | 1.6 | 0              | 0   | 2             | 2.2  |
|                | Supportive   | Positive          | 22       | 17.2          | 41  | 25.5           | 27  | 29.0          |      |
|                |              | Negative          | 5        | 3.9           | 3   | 1.9            | 6   | 6.5           |      |
| Evaluation     | Help-seeking |                   | Positive | 4             | 3.1 | 2              | 1.2 | 1             | 1.1  |
|                |              |                   | Negative | 5             | 3.9 | 2              | 1.2 | 3             | 3.2  |
|                | Supportive   | Positive          | 0        | 0             | 0   | 0              | 0   | 0             |      |
|                |              | Negative          | 11       | 8.6           | 11  | 6.8            | 3   | 3.2           |      |
| Potency        | Help-seeking | Positive          | 6        | 4.7           | 8   | 5.0            | 5   | 5.4           |      |
|                |              | Negative          | 17       | 13.3          | 21  | 13             | 5   | 5.4           |      |

|            |          |     |      |     |      |    |      |
|------------|----------|-----|------|-----|------|----|------|
| Supportive | Positive | 35  | 27.3 | 33  | 20.5 | 12 | 12.9 |
|            | Negative | 14  | 10.9 | 11  | 6.8  | 5  | 5.4  |
|            | Total    | 128 | 100  | 161 | 100  | 93 | 100  |

## 6. Interactive behavior change with time

There were no statistically significant differences in interactive behaviors among the three time periods ( $\chi^2 = 2.910, p > .05$ ). The ratios were very similar for the three time periods. This suggests that participants tended to provide assistance at a consistent level from the beginning of the game to the end.

Table 6: The percentage of interactive behavior by time period

| Classification             | First period |      | Second period |      | Third period |      |
|----------------------------|--------------|------|---------------|------|--------------|------|
|                            | Count        | %    | Count         | %    | Count        | %    |
| Interactive Behavior Model |              |      |               |      |              |      |
| Help-seeking               | 41           | 32.0 | 62            | 38.5 | 40           | 43.0 |
| Supportive                 | 87           | 8.0  | 99            | 61.5 | 53           | 57.0 |
| Total                      | 128          | 100  | 161           | 100  | 93           | 100  |

## Discussion

An article, by Clark and Sampson (2008), addresses a broad array of social factors for creating open discussion. The article specifically focuses on the generation of new ideas in small groups, and finds that rudeness—disagreeing with others in a direct and confrontational way—is less effective in generating new ideas than polite disagreement.

Boyle and Connolly (2009) assert that “understanding the relationship between gender and computer games is extremely important for creating computer games that will function as effective educational tools.” This study examined gender differences in dialogue during game playing. In particular, male and female players and their semantic usage in help-seeking and supportive behaviors, and changes in interactive behaviors as the game progressed, were analyzed. The following conclusions are offered:

1. *Interactive behavior in general*: Positive words are very important to motivate teammates to attain the goal state (Custer & Aarts, 2005, 2007). Context-sensitive help functions are especially susceptible to gaming behavior directed at better performance (Bartholomé et al., 2006). In the present study, children tended to use directive or ordering language in the cooperative-competitive game. However, more positive than negative statements were observed in general. The context of this game can generate a

public-goods dilemma (De Cremer, Snyder, & Dewitte, 2001) that accelerates the speed of play to complete the game, which is mainly the result of increasing interpersonal trust as playing time increases.

2. *Gender differences in interactive behavior*: Men and women differ in emotional arousal; women have been reported to use positive expression more frequently (LaFrance, Hecht, & Paluck, 2003; Schirmer, Kotz, & Friederici, 2005). In this study, girls tended to use more encouraging statements than boys, and boys tended to use more negative expressions, such as words with scolding connotations, in playing the game. In the sense, the research hypothesis 2 was supported.
3. *Gender differences in playing stages*: Help-seeking among adolescents has been described as a necessary ingredient in successful coping (Grinstein-Weiss, Fishman, & Eisikovits, 2005). Children's coping includes help-seeking for academic problems, yet they do not always seek help when it is needed, and help-seeking generally declines during early adolescence (Grades 5–6) (Marchand & Skinner, 2007). That result seemed only proved at age related study, from game playing perspective, the other observations of this study show that boys' helping seeking behavior was less at the beginning stage, in contrast, relatively high help-seeking behavior while the other team surpassed. Thus, the research hypothesis 1 was supported.

### **Concluding Remarks**

In summary, the context of the Strike Up game can be helpful in group cooperative and competitive learning. The interactive discussions supported by the context of the Strike Up game also help to improve children's social abilities. The analysis of our study data found that the meaning dimensions described by Osgood and Tanaka (1965) and Osgood et al. (1975) could be confirmed, even some 40 years later in a totally different subject population. We also verified that the activity dimensions explained most of the dialogue. The findings further demonstrated that positive semantic words were nearly identical in female groups of subjects. Self-monitoring of expressive behavior comprises self-observation and self-control, and is guided by situational cues for social adequacy (Gangestad & Snyder, 2000). Girls in this study displayed better self-monitoring behavior than boys, from their conversation while playing the game. Thus, the use of internet digital games as a stimulus material for the semantic classification of help-seeking and supportive behaviors in experiments can be considered very reliable.

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# A Learning Style Perspective to Investigate Students' Perceptions in Choosing the Most-Beneficial Educational Systems

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**Abstract:** In recent years, researchers have been engaged in the development of adaptive learning systems that provide the best way for helping individual students improve their learning performance. Among various personal data in student profiles, learning styles have been considered as being one of the factors that need to be taken into account in developing adaptive learning systems. Several studies have shown that, by taking learning styles into account, learning systems can benefit students more owing to the provision of personalized learning procedures or contents that match the cognitive processes of individuals. However, few studies have been conducted on investigating if students have the ability to choose the most-fit e-learning systems for themselves in terms of the learning style perspective; moreover, it is interesting to investigate the factors that affect students in choosing e-learning systems. In this paper, we aim to investigate these issues by using two versions of an educational game developed based on the sequential/global dimension of the learning style proposed by Felder and Silverman. A total of 288 students participated in the study. The experimental results showed that, the choices made by the students were not related to their cognitive process or learning styles; instead, most students chose e-learning systems by intuitions based on personal preferences. Such findings not only imply that students might not have the ability to choose the most-beneficial educational systems on their own, but also reveal the importance and necessity of providing scaffoldings and developing adaptive learning systems for guiding the students to learn in a more effective way.

**Keywords:** learning styles, cognitive process, human factors, educational computer games, adaptive learning

## 1. Background and Objectives

The provision of personalized or adaptive learning support for individual students has been recognized as being one of the most important features of e-learning systems [1]. By referring to the personal information, the adaptive learning systems can either present personalized content for individual students or guide them to learn by providing a personalized path [2-3]. In the past decade, lots of personalized or adaptive learning systems have been developed based on various personal information of students, such as their profiles (e.g., gender, age, knowledge level, and background data), learning portfolios, and preferences [4-5]. For example, Huang and Yang (2009) designed a semantic Web 2.0 system to support different types of knowledge and adaptive learning [6]. They found that

combining the advantages of blogs and wikis were able to comprehend various types of knowledge and improve students' learning performance. In the meantime, Romero, Ventura and Bra (2009) proposed an advanced architecture for a personalization system to facilitate Web mining [7]. They developed a recommender engine and integrated it into the learning system for recommending to individual students the most appropriate links or Web pages to visit next. Furthermore, Klačnja-Milićević, Vesin, Ivanović and Budimac (2011) proposed a recommendation module of a programming tutoring system, which could automatically adapt to the interests and knowledge levels of learners [8].

Among those factors that affect the provision of personalized learning contents or paths, learning styles have been recognized by researchers as being an important factor [9]. Keefe (1987) stated that "learning style is a consistent way of functioning that reflects the underlying causes of learning behavior"[10]. He further indicated that learning style is both a student characteristic indicating how a student learns and likes to learn, as well as an instructional strategy informing the cognition, context and content of learning [11]. Previous studies have reported that the students' learning performance could be improved if proper learning style dimensions can be taken into consideration when developing adaptive learning systems [9]. For example, Graf, Liu and Kinshuk (2010) investigated the navigational behavior of students in an online course within a learning management system to look at how students with different learning styles prefer to use and learn in such a course. It was found that students with different learning styles used different strategies to learn and navigate through the course [12]. Hauptman and Cohen (2011) examined whether students with a certain learning style would benefit more from learning 3D geometry than other students. Their findings indicated a differential impact of virtual environments on students with different modal and personal learning styles [13].

Although adaptive learning has been widely discussed and has been recognized as being an effective approach for helping students improve their learning performance, few studies have been conducted to investigate whether students can choose the most-fit e-learning systems for themselves. In this study, an experiment has been conducted by providing students two versions of an educational computer game based on the sequential/global dimension of the learning style proposed by Felder and Silverman (1988) to investigate the following research questions [14]:

- (1) Can students choose the educational computer games that fit them best from the learning style perspective?
- (2) Is there any difference between male and female students in choosing the educational computer games?
- (3) What are the factors that affect the students in choosing the educational computer games?

## **2. Literature Review**

There have been several learning style theories proposed by researchers, such as those proposed by Keefe (1979) [15], Kolb (1984) [16] and Felder and Silverman (1988) [14]. Several previous studies have demonstrated the use of learning styles as one of the parameters of providing personalized learning paths or contents. For example, Tseng, Chu, Hwang and Tsai (2008) developed a personalized learning system by taking both the knowledge levels and the learning styles of students into account [3]. Later, Kinshuk, Liu and Graf (2009) propose an adaptive learning approach by analyzing the interactions between students' learning styles, behaviors, and their performance in an online course that was mismatched regarding their learning styles to find out which learners need more help, such that proper learning supports could be provided accordingly [17]. Furthermore,

Bolliger and Supanakorn (2011) examined the effects of learning styles on learner perceptions of the use of interactive online tutorials. Learners were categorized into five learning style categories and four learning modalities. The responses to a questionnaire in terms of survey dimensions were analyzed in order to ascertain differences based on learning style dimensions, gender and class standing [18].

Among those learning style theories, the Felder–Silverman learning style has been widely adopted and has been validated by various studies [19-20]. For example, Filippidis and Tsoukalas (2009) developed a web-based adaptive educational system based on the sequential–global dimension of Felder–Silverman’s learning style theory [9]. The adaptive learning system provides different versions of images to present the same content with different detailed levels; that is, a detailed version of the images is given for the sequential learning style students, while a non-detailed version is presented to the global learning style students. Therefore, in this study, two versions of an educational computer game are developed based on the sequential/global dimension for investigating the students' ability and decision-making process in choosing the most-fit learning system.

### **3. Experiment Design**

#### *3.1 Participants*

As the educational computer games were developed for an elementary school natural science course, a total of 288 in an elementary school of southern Taiwan voluntarily participated in the study. All of the students were taught by the same instructor who had taught that natural science course for more than ten years.

#### *3.2 Measuring Tools*

The measuring tool adopted in this study was the Index of Learning Styles (ILS) Questionnaire developed by Solomon and Felder (2001) [21] based on the learning styles proposed by Felder and Silverman (1988) [14]. The ILS measure consists of four dimensions, that is, sensing/intuitive, visual/verbal, active/reflective and sequential/global, each of which contains 11 items. In this study, the "sequential/global" dimension was adopted. Some of the questionnaire items of this dimension are "I tend to (a) understand details of a subject but may be fuzzy about its overall structure. (b) understand the overall structure but may be fuzzy about details." and "Once I understand (a) all the parts, I understand the whole thing. (b) the whole thing, I see how the parts fits." Choosing "a" indicates that the tendency degree of "sequential" is increased; otherwise, the tendency degree of "global" is increased.

#### *3.3 Sequential and Global Style Educational computer games*

In this study, two versions of an educational computer game are developed for the "knowing the plants on school campus" unit of an elementary school natural science course based on the sequential/global dimension of the Felder–Silverman learning style. The objective of the subject unit is to foster the students’ competence in identifying and differentiating a set of target plants.

The game was implemented by employing the RPG Maker developed by Enterbrain Incorporation. The background of the game is about an ancient kingdom in which the people are infected by poisoned water in a river. Following the hints from an ancient medical book, the king decides to look for the plants that are able to cure his people.

The game designed for sequential style learners provides a "step-by-step" interface to guide the students of this style to complete the learning missions since they tend to think linearly and learn in small incremental steps [14]. Figure 1 shows the interface of the sequential style game. The learners are guided by this version of the educational computer game to the next mission only after the present mission has been completed.



Figure 1. The sequential style game

On the other hand, the global style game provides a "global mission map" that enables the students to select any mission or jump to any game scene since they tend to learn with holistic thinking processes in large leaps [14]. Figure 2 shows the interface of the global style version of the educational computer game.



Figure 2. The global style game

### 3.4 Experiment Procedures

Before the experiment, the students took the learning style questionnaire for categorizing them into sequential or global style. Following that, a one-hour presentation was made by the teacher to show them the two versions of the educational computer game, including the differences and similarities between the two versions; moreover, the students were informed that the two versions of the game had identical content related to the "knowing the plants" unit of the natural science course. After the presentation, the students were asked to make the choice between the two versions of the game and write down the reasons for the choice.

## 4. Results

### 4.1 Relationships between students' learning styles and their choices of the e-learning systems

From the learning style questionnaire result, it was found that 134 of the participants were sequential style students, while 154 of them were of global style. Table 1 shows the ratio of the choices made by the different learning style students. It is found that 86.1% of the students chose the global style system, while only 13.9% of them chose the sequential style system; that is, most of the students prefer the global style version of the educational computer game. Moreover, 86.5% of the sequential style students chose the global style system and only 14.3% of the global style students chose the sequential style system.

Table 1. Descriptive data of students' learning styles and their choices of the educational computer game

|                          |            | Choices of the educational computer game |                      | Total |
|--------------------------|------------|--|----------------------|-------|
|                          |            | Sequential                               | Global               |       |
| Students' Learning Style | Sequential | 18 (13.5%)                               | 116 ( <b>86.5%</b> ) | 134   |
|                          | Global     | 22 (14.3%)                               | 132 (85.7%)          | 154   |
| Total                    |            | 40 (13.9%)                               | 248 ( <b>86.1%</b> ) | 288   |

To further investigate the relationships between students' learning styles and their choice of the educational game, the Chi-Square analysis was applied to the questionnaire data, as shown in Table 2. It is found that the correlation between the students' learning styles and their choice of the learning systems was not statistically significant ( $r = 0.44$ ,  $p > .05$ ). Consequently, it is concluded that the choices made by the students were not related to their learning styles; that is, the students did not choose the educational games by considering the underlying needs for learning effectiveness.

Table 2. The Chi-Square result of students' learning styles and their choices of the educational games

|                              | Value | df | Asymp.Sig. (2-sided) |
|------------------------------|-------|----|----------------------|
| Pearson Chi-Square           | .044  | 1  | .835                 |
| Likelihood Ratio             | .044  | 1  | .835                 |
| Linear-by-Linear Association | .043  | 1  | .835                 |
| N of Valid Cases             | 288   |    |                      |

#### 4.2 Relationships between genders

Table 3 shows the descriptive data of male (N = 158) and female (N = 130) students in choosing the two versions of the educational computer game. It is found that 137 out of 154 male students and 121 out of 130 female students chose the global style system, indicating that both the male and the female students prefer the global style version of the educational computer game. Moreover, it was found that 81.1% of the male sequential style students (60 out of 74) and 93.3% of the female sequential style students (56 out of 60) chose the global style game.

Table 3. Descriptive data of students of different genders in choosing the educational computer games

| Gender              |                   |            | Choices of the educational computer game |             |       |
|---------------------|-------------------|------------|--|-------------|-------|
|                     |                   |            | Sequential                               | Global      | Total |
| Male<br>(N = 154)   | Learning<br>Style | Sequential | 14 (18.9%)                               | 60 (81.1%)  | 74    |
|                     |                   | Global     | 17 (20.3%)                               | 67 (79.7%)  | 84    |
| Female<br>(N = 130) | Learning<br>Style | Sequential | 4 (6.7%)                                 | 56 (93.3%)  | 60    |
|                     |                   | Global     | 5 (7.2%)                                 | 65 (92.8%)  | 70    |
| Total               |                   |            | 40 (13.9%)                               | 248 (86.1%) | 288   |

By applying the Chi-Square analysis, it is found that the correlations between the choices of the educational computer games and the learning styles of male and female students are  $r = 0.43$  ( $p > .05$ ) and  $r = 0.11$  ( $p > .05$ ), respectively, which were not statistically significant. Consequently, it is concluded that, for both genders, the choices of the educational computer games were not related to their learning styles.

#### 4.3 The factors that affect the students in choosing the educational computer games

In order to investigate the factors that affect the students in choosing the educational computer games, the feedback from the students were analyzed. Table 4 shows descriptive statistics of the feedback from the students in stating the reasons for making the choices. It was found that 73.9% of the participants response that "The game I chose looks more interesting than the other"; 71.7% of the participants made choices because they felt that "The game I chose looks more relaxing"; 65.2% of the participants addressed that "Such an operational interface conforms to my previous experiences of playing game" and 66.7% of the participants stated that "The design of the game seems to be easier to operate".

To sum up, the factors that affect the students in choosing the educational computer games include "interesting", "relaxing", "ease of use" and "conforming to previous experiences", which are irrelevant to the cognitive process of individual students with different learning styles. Consequently, it is necessary to develop adaptive learning systems for guiding the students to learn in an appropriate way, including proving personalized learning interface or paths to present learning content in the most beneficial manner for individual students with different learning styles.

Table 4. Descriptive statistics of factors that affect students in choosing educational computer games

| Factors  | Global style students who chose sequential style game (N = 116) |         | Sequential style students who chose Global style game (N = 22) |         | Total (N=138) |         |
|--|---|---------|--|---------|---------------|---------|
| 1. The game I chose looks more interesting than the other.                           | 86  | (74.1%) | 16   | (72.7%) | 102           | (73.9%) |
| 2. The game I chose looks more relaxing.   | 84  | (72.4%) | 15   | (68.2%) | 99            | (71.7%) |
| 3. Such an operational interface conforms to my previous experiences of playing game | 74  | (63.8%) | 16   | (72.7%) | 90            | (65.2%) |
| 4. The design of the game seems to be easier to operate.                             | 75  | (64.7%) | 17   | (77.3%) | 92            | (66.7%) |

## 5. Discussion and Conclusions

In this study, we investigate students' perceptions in choosing the most-beneficial educational systems from the perspective of learning styles. The participants were asked selected one of the two versions of an educational gamed developed based on the sequential/global dimension of the learning style proposed by Felder and Silverman. The experimental results on 288 students showed that, the choices made by the students were not related to their cognitive process or learning styles; instead, most students choose e-learning systems based on intuitions or preferences, such as "interesting", "relaxing", "ease of use" and "conforming to previous experiences". Such findings provide a possible explanation to what was reported by Wang and Chen (2010) that choosing educational computer games based on preferences does not benefit the students since the choices did not comply with the students' cognitive process or learning styles [22].

Furthermore, the findings also reveal the importance of providing learning supports and developing adaptive learning systems to help the students learn in a most beneficial scenario by taking the cognitive process or learning styles of individual students into consideration. That is, this study gives an evidence for supporting the development of adaptive learning systems; in particular, for those studies that employ learning styles as a factor for adapting learning content, presentation styles and learning paths for individual students.

On the other hand, although this study showed some significant experimental results, the use of the computer educational games in this study might not be able to represent the common features of most learning systems; moreover, the implication of this study is limited owing to the investigation was conducted on only one dimension of a learning style. In the future, more studies are needed for investigating relevant issues using various learning systems by taking different learning dimensions into account.

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# Prior Knowledge and Cognitive Styles in Personalized Learning

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**Abstract:** In the past decade, a number of personalized learning systems have been developed. Prior knowledge has widely been considered in the development of personalized learning systems. On the other hand, previous research suggested that cognitive styles have great effects on student learning. To this end, this study examine how cognitive styles, affect learners' reactions to a personalized and non-personalized learning systems based on learners' prior knowledge. Forty-four undergraduate and postgraduate students participated in this study. The results show that Serialists show positive reactions to the personalized learning system while Holists demonstrate equal reactions to the personalized learning system and the non-personalized learning system. The implications of these results for the design of personalized learning systems are discussed.

**Keywords:** Cognitive Styles, Personalization, Prior Knowledge

## 1. Introduction

Web-based learning systems provide students with multiple ways so that they can develop their own learning approaches. This may be the reason why Web-based learning systems are so popular in educational settings [20]. The reason for such popularity is that the Web-based learning systems offer many advantages over traditional classroom-based training. On the other hand, there is great diversity among learners, who may have heterogeneous backgrounds, in terms of their knowledge, skills and needs [4]. Moreover, learners who have various backgrounds may prefer to interact with the Web-based learning systems with different ways [4]. Thus, there is a pressing need for the development of Web-based learning systems that can support the preferences of each learner [2]. To address this issue, personalization is widely used in the field of Web-based learning. Personalization tailors content, structure and/or presentation to match the preferences of each individual according to his/her characteristics and needs [25] [14] [16]. However, the delivery of personalization is complex because the adaptation to each individual requires the understanding of his/her preferences [1] and prediction of his/her behavior [9]. Therefore, understanding each learner's preferences is an essential issue for the delivery of personalization.

As showed in the previous discussion, students have diverse preferences when using the Web-based learning system. Thus, human factors play an important role in the development of the Web-based learning systems, ranging from prior knowledge [15] [19] to cognitive styles [3] [7]. Among various characteristics, prior knowledge is predominant in personalization, especially for Web-based learning [27]. Empirical

evidence has suggested that personalizing Web-based learning systems based on learners' prior knowledge can improve their learning performance [10] [23] [28]. Such systems are useful because they can deliver tailored services in a way that will be most appropriate and valuable to the learners [2]. However, they mainly focus on prior knowledge and ignore the effects of other human factors.

In addition to prior knowledge, cognitive styles also play an essential role in Web-based learning and affect each individual's learning preferences and behavior [5]. Thus, it is not sufficient to provide effective personalization to take into account prior knowledge. In other words, cognitive styles should also be taken into account in the delivery of personalization. Within the area of cognitive styles, Witkin's Field Dependence [29] has emerged as one of the most widely studied human factors. Witkin's Field Dependence has a conceptual link with the other dimension of cognitive style, i.e., Pask's Holism/Serialism. Jonassen and Grabowski [17] describe Holists as preferring to process information in a 'whole-to-part' sequence. However, the different preferences between Field Dependent and Field Independent users can be divided more clearly and logically than the differences between Holists and Serialists. In other words, identifying the different preferences of Holists and Serialists is more complex. To this end, this study investigates Pask's Holism/Serialism, instead of Witkin's Field Dependence.

In summary, the study presented in this paper attempts to investigate personalized Web-based learning systems from the perspective of multiple human factors. In harmony with the main stream of personalization, this study develops a personalized Web-based learning system based on learners' prior knowledge and then examines how cognitive styles affect learners' reactions to this personalized Web-based learning system. The ultimate aim of this study is to incorporate both prior knowledge and cognitive styles into the delivery of personalization because these two human factors are widely applied in the delivery of personalization [22]. Thus, the outcome of this study can not only be used to improve the development of personalized Web-based learning systems, but also provide concrete solutions to personalize other Web-based applications, such as online shopping and search engines. By doing so, the quality of these applications can be improved.

## **2. Methodology Design**

To effectively achieve the aforementioned aim, an empirical study was conducted. This section describes the methodology design of the empirical study, including participants, research instruments, experimental procedures and data analyses.

### **2.1 Participants**

Previous research indicated that there is a need to investigate how to provide additional support for low-prior knowledge learners [6]. Thus, this study focuses on low-prior knowledge learners. More specifically, 44 undergraduate and postgraduate students from some universities in Taiwan participated in our study voluntarily. A

request was issued to students in lectures, and further by email, making clear the nature of the studies and their participation. All participants had the basic computer and Internet skills necessary to use a Web-based learning system but they do not any understanding of the subject content of the Web-based learning system described in Section 2.2.1.

## 2.2 Research Instruments

The research instruments used in this study included (1) two Web-based learning systems used to teach students “Interaction Design”, (2) Study Preferences Questionnaire used to measure students’ cognitive styles, (3) task sheet used to describe practical tasks that students need to do when interacting with the Web-based learning systems, and (4) post-test used to assess how students have learnt after using the Web-based learning systems.

### 2.2.1 Web-based Learning Systems

In this study, two Web-based learning systems are developed. Both of them give an introduction to Interaction Design and provide two kinds of navigation tools. One is Keyword Search, which allows learners to locate specific information based on their particular needs. The other one is Hierarchical Map, which provides a global picture of the subject content. Nevertheless, these two Web-based learning systems provide personalization for learners with different levels of prior knowledge. One is for low prior knowledge learners, i.e., a personalized learning system, while the other is for high prior knowledge, i.e., a non-personalized learning system.

The design rationale of the two Web-based learning systems is based on a framework proposed by Chen, Fan and Macredie [6]. Learners with low prior knowledge lack sufficient understanding of subject content so there is a need to provide them with simple design and more visual cues. Thus, the personalized learning system provides a single keyword search so that the learners can make a simple query. Furthermore, keywords searched are highlighted with yellow color in the display of the results so that learners can easily identify whether results are relevant. Additionally, there is a simple tree map (Figure 1), with which learners can construct knowledge step by step. Conversely, learners with high prior knowledge have a great deal of the understanding of subject content so they can accept sophisticated design and fewer visual cues. Therefore, the non-personalized learning system provides multiple keyword search with Boolean operators. Keywords are not highlighted but there is a complete tree map (Figure 2), with which learners can jump from one section to the other section directly.

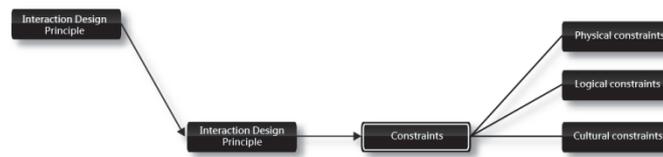


Figure 1. Hierarchical Map (Personalized learning system).

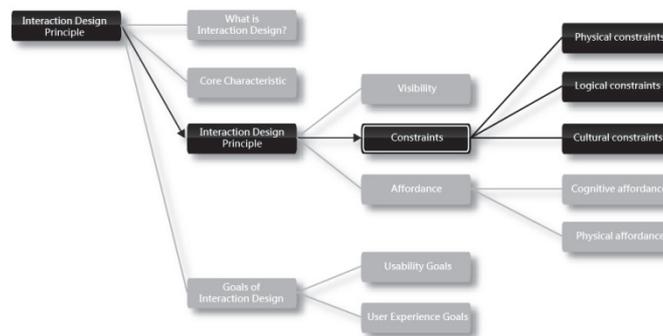


Figure 2. Hierarchical map (non-personalized learning system).

### 2.2.2 Task Sheet

When interacting with the Web-based learning systems, the participants were given a task sheet, which described the tasks that learners need to perform. To reduce the bias of this study, there are two different kinds of tasks. One is a factual question while the other is an essay question. The former focuses on a single concept and there is only one standard answer for the question. The latter includes multiple concepts so learners have to realize the relationships of various keywords described in the questions. Learners need to complete these two kinds of tasks. The starting time and the end time for each student were recorded.

### 2.2.3 Post-test

The post-test was designed to assess how much they have learnt from the Web-based learning systems. The post-test was presented in a computer-based format and included 20 multiple-choice questions. Each question included three different answers and an “I don’t know” option but there was only one right answer. The questions

covered all eight sections of the Web-based learning program from basic concepts to advanced skills. Students were allotted 20 minutes to take the post-test and were not allowed to examine the content presented in the system at the same time.

#### 2.2.4 Study Preferences Questionnaire (SPQ)

As suggested by Section 1, further empirical studies are needed to examine the differences between Holists and Serialists so the study presented in this paper investigates Holism/Serialism, instead of Field Dependence/Independence. In an attempt to devise a relatively quick and easy measure of Holist and Serialist biases, Ford [12] developed the Study Preferences Questionnaire (SPQ), which is an 18-item inventory for categorizing learners as Holists or Serialists. In this vein, students were provided with two sets of statements. They were asked to indicate their degree of agreement with either statement or to indicate no preferences [12]. As the SPQ has been used in several studies [8] [11] [13] [26], it was chosen for this study, which identified Holists and Serialists by using criteria suggested by the original producer [12]: (a) if users agree with over half of the statements related to Holists, they are identified as Holists; (b) if users agree with over half of the statements related to Serialists, they are then considered as Serialists, and (c) if users agree with half of the Holist statements and half of the Serialist Statement, they are then considered as Intermediate. The reliability of the SPQ is adequate ( $\alpha = 0.67$ ) [21].

### 2.3 Experimental Procedures

There were two scenarios in this study. One is a personalized scenario, in which learners used a Web-based learning system that matched with their prior knowledge. The other is a non-personalized scenario, in which learners used a Web-based learning system that did not match with their prior knowledge.

Regardless the personalized scenario or non-personalized scenario, learners need to complete the tasks when they interact with the Web-based learning systems. After finishing the tasks, they were required to go into the final step, i.e., the post-test. They needed to take the post-test to evaluate how much they have learned from the Web-based learning systems, which is regarded as their learning performance.

### 2.4 Data Analysis

In this study, seven attributes were analyzed with data mining techniques, including (1) the total time used for keyword searching, (2) the frequencies of using keyword searching, (3) the total number of movements made, (4) the total number of repeated visiting, (5) the total number of visited pages, (6) the number of pages in each keyword searching, and (7) the number of pages visited each second.

Among various data mining techniques, K-means was used to conduct data analyses for this study because it was widely used to analyze learners' on-line learning

behaviors. In particular, our recent studies [7] found that K-means is a useful tool to cluster learners' behavior. However, a major limitation of using the K-means algorithm is that the number of clusters needs to be predefined. In other words, there is a need to identify the most suitable number of clusters to perform the K-means algorithm. Such an issue can be treated as parameter exploration [18], which is used to decide the suitable value of parameters. The parameter exploration is useful when a dataset is not large. Thus, the K-means algorithm is suitable for this study because the dataset was not large. Therefore, the parameter exploration was applied to decide the parameters of the K-means algorithm in this study.

### 3. Results and Discussion

#### 3.1 Overview

As indicated in Section 2.4, seven attributes were considered in data analyses. The data obtained from these seven attributes had been normalized firstly before utilizing the K-means algorithm because these attributes are not comparable. More specifically, a big difference exists among the range of these attributes. Subsequently, the clusters are created with the K-means and they are divided into two groups, i.e., the personalized scenario and non-personalized scenario, each of which has four clusters. After carefully examining the details of the clusters in each scenario, we found that one cluster can be treated as outliers in each scenario because there are few number of cases. Therefore, only three clusters are used for further investigation in each scenario.

Furthermore, we found that two attributes show differences among the three clusters for each scenario, i.e., the number of pages visited for each keyword search (page/keyword) and the number of pages visited per second (page/task time). Additionally, we also examine corresponding features of each cluster, including post-tests scores, task time and cognitive styles.

##### 3.1.1 Personalized Scenario

Three clusters are applied for the investigation of this scenario. Cluster 1 is the major cluster, which includes almost half of the participants. The trend of each cluster is described below.

**C1 (N=10):** The number of pages read with each keyword search (page/keyword) is higher than the number of pages read per second (page/task time) and they get the best post-test score (Mean=10.40; Standard Deviation=2.59), regardless the personalized or non-personalized scenario.

**C2 (N=6):** The trend of this cluster is similar to Cluster 1 in the personalized scenario. However, learners get the lowest post-test score (Mean=9.67; Standard Deviation = 3.61) among the three clusters in the personalized scenario.

**C3 (N=5):** The trend of Cluster 3 is similar to Cluster 1 and Cluster 2. However, learners in Cluster 3 spend the longest task time (Mean=0.31; Standard Deviation = 0.07) among the three clusters of the personalized scenario.

### 3.1.2 Non-Personalized Scenario

Like the Personalized Scenario, there are also three clusters considered in the non-personalized scenario. The trend of each cluster is described below:

**C1 (N=5):** The number of pages read with each keyword search (page/keyword) is lower than the number of pages read per second (page/task time) and they get the best post-test score (Mean=9.60; Standard Deviation = 1.34) among the three clusters of the non-personalized scenario.

**C2 (N=7):** The trend of this cluster is similar to Cluster 1 in the non-personalized scenario. However, the post-test score (Mean=8.57; Standard Deviation = 3.95) is not only the lowest one in the non-personalized scenario, but also the lowest score among the six clusters. The majority of females appear in this cluster.

**C3 (N=7):** The trend of Cluster 3 is similar to Cluster 1 and Cluster 2. However, learners in this cluster spend the longest task time (Mean=0.50; Standard Deviation = 0.27), regardless the personalized or non-personalized scenario.

### 3.2 Learning Performance

This section compares the differences between students' learning performance in the personalized scenario and those in the non-personalized scenario. To address such an issue, the students' post-test scores and task time were used to evaluate their learning performance.

Regarding the post-test score, students in the personalized scenario performed better than those in the non-personalized scenario (Figures 3 to 5). In other words, students can benefit from the personalized scenario to get high post-test scores whereas they may obtain low post-test scores in the non-personalized scenario. In this study, the personalized scenario provides a simple interface while the non-personalized scenario presents a complex interface. This finding suggests that the simple interface is suitable for students with low prior knowledge to help them learn an unfamiliar topic, which in turn, they can obtain high performance. Conversely, the complex interface in the non-personalized scenario can not only make students obtain low performance in the post-test, but also let students waste much time in an unsuitable environment.

Regarding task time, the students in the personalized scenario spent less time completing the tasks than those in the non-personalized scenario (Figure 6). It means that students in the personalized scenario can not only get a high post-test score, but also can use an efficient way to complete their tasks. The results echoes those from the post-test scores, which indicated personalizing instructional material to matches with learners' characteristics can help learners not only achieve good performance but also accomplish their tasks in an efficient way.

After examining Figure 7 and Figure 8, we found that learners among the three clusters in the personalized scenario spend similar amount of time completing the tasks. In other words, there is no big difference among the three clusters. However, there are big diversities among the three clusters in the non-personalized scenario. Learners in Cluster 2 spent the least amount of task time while those in Cluster 3 spent the most amount of task time, regardless the personalized or non-personalized scenario. It implies that not all of the learners can overcome the challenges caused by non-personalization so unpredictable task time exists in the non-personalized scenario.

### 3.3 Cognitive Styles

In addition to overall learning performance, we also examined how Holists and Serialists react differently to the personalized scenario and the non-personalized scenario.

#### 3.3.1 Serialists

Regarding the personalized scenario, learners in Cluster 2 and Cluster 3 got lower post-test score. On the other hand, few Serialists appear in these two clusters (Figure 9). Regarding the non-personalized scenario, learners in Cluster 2 and Cluster 3 got lower post-test score. On the other hand, most Serialists appear in these two clusters (Figure 10). These results suggest that the non-personalized scenario has negative effects on Serialists. This is probably because the non-personalized learning system provides a complex keyword search, which can be used to combine to search different keywords. This design approach does not support the needs of Serialists, who focus on only one thing at a time.

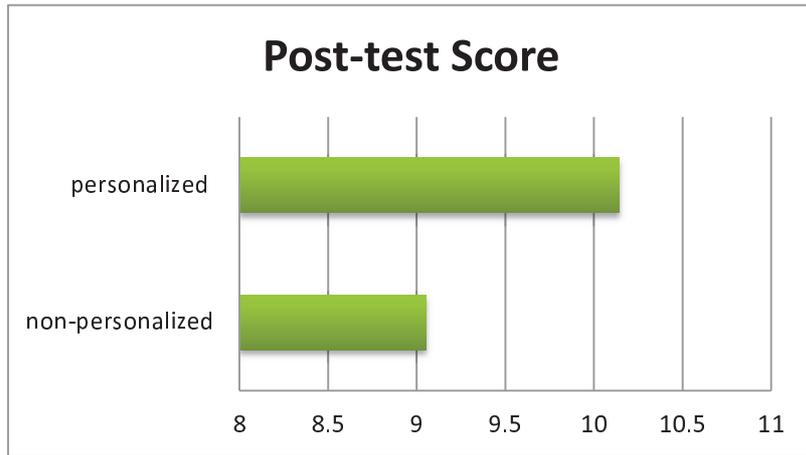


Figure 3. Post-test score (overall).

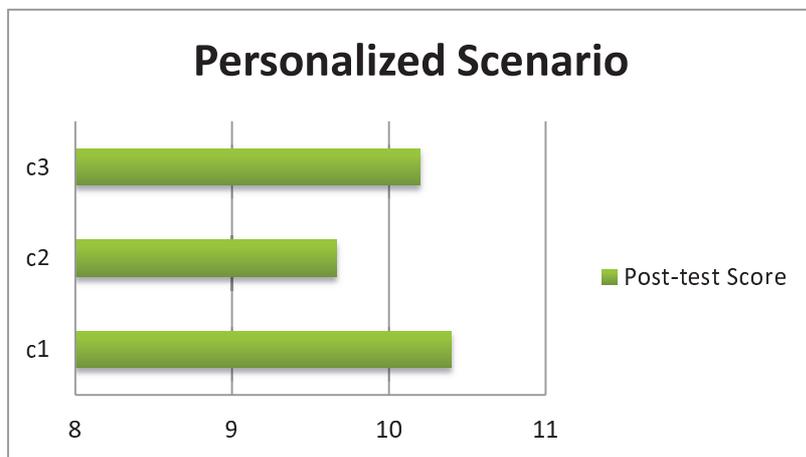


Figure 4. Post-test score (personalized scenario).

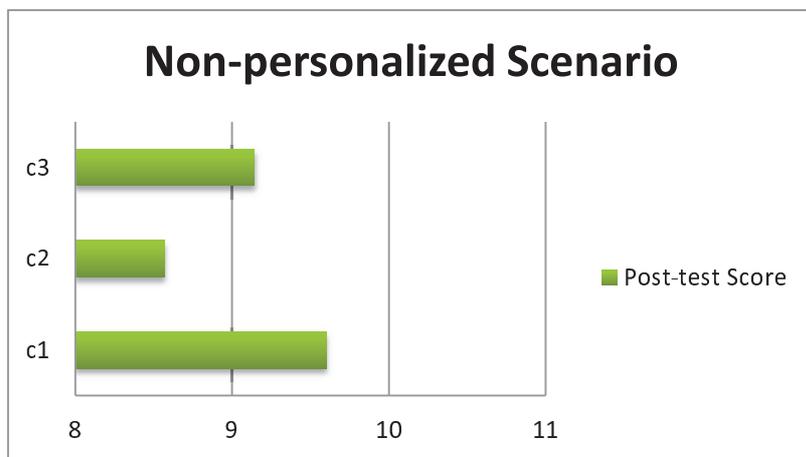


Figure 5. Post-test score (non-personalized scenario).

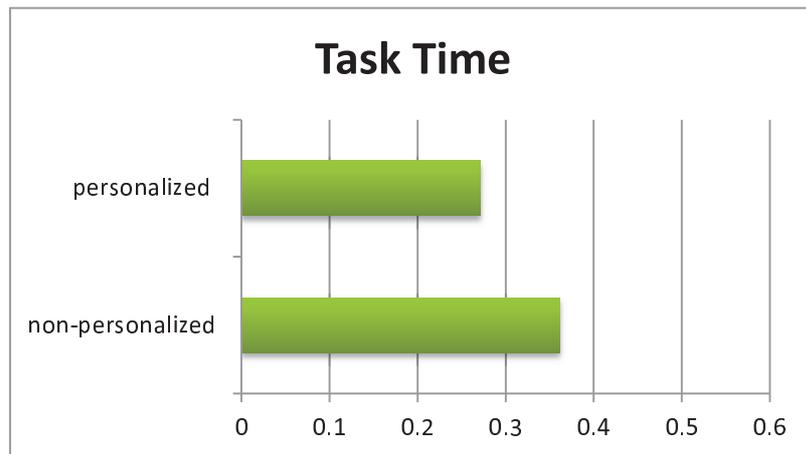


Figure 6. Task time (overall).

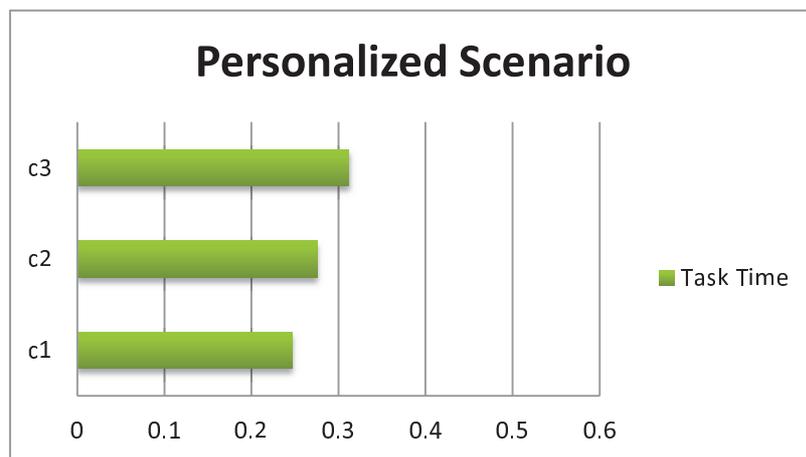


Figure 7. Task time (personalized scenario).

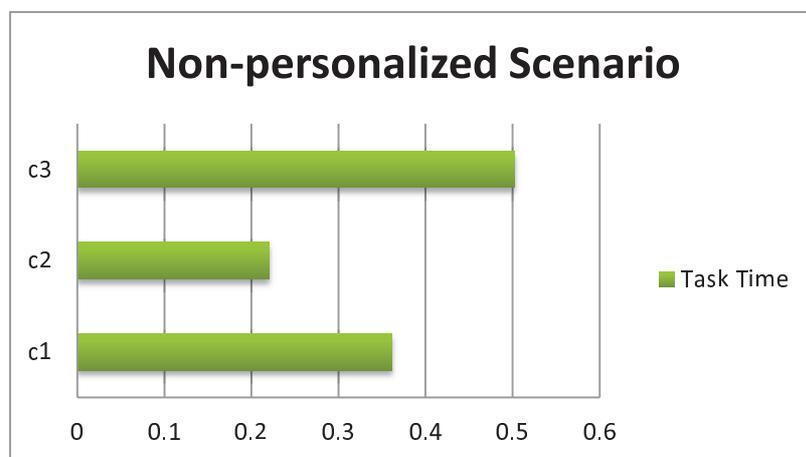


Figure 8. Task time (non-personalized scenario).

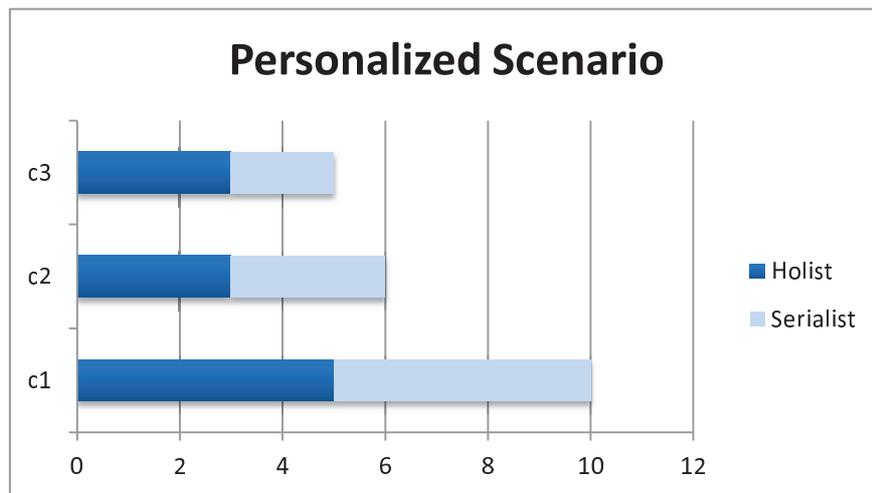


Figure 9. The distribution of Serialists and Holists in personalized scenario.

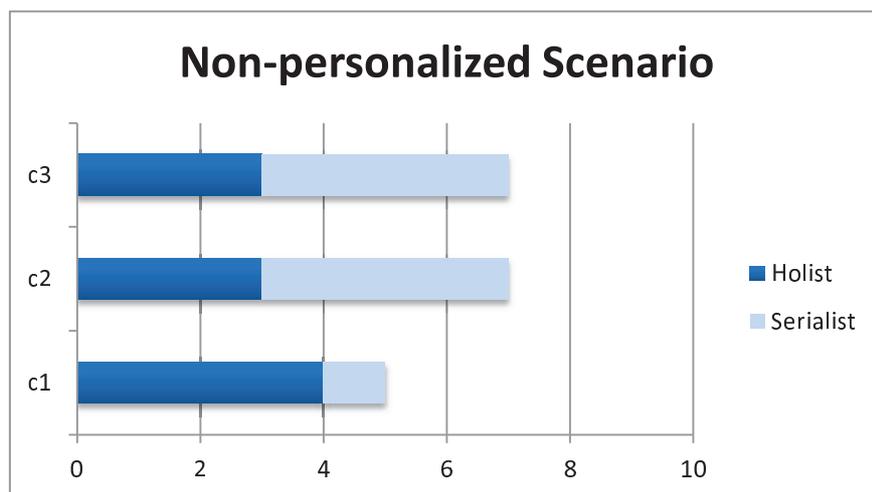


Figure 10. The distribution of Serialists and Holists in non-personalized scenario.

### 3.3.2 Holists

As showed in Figures 9 and 10, Holists are evenly distributed in the three clusters, regardless the personalized scenario and the non-personalized scenario. In other words, the Holists do not show strongly different reactions to the personalized scenario and the non-personalized scenario. Only a simple keyword search and a partial hierarchical map are provided in the personalized learning system, where learners can merely get a local picture, instead of an overall picture. In theory, this scenario, thus, cannot satisfy the needs of Holists, who would like to get a global view. However, the aforementioned results suggest that Holists have potential to overcome difficulties that they meet in the personalized scenario. This is probably because the

flexibility is included in the personalized learning system. More specifically, hypertext links are applied to connect other main categories and related categories and the hierarchical map is clickable. Thus, the Holists can gradually get the global picture by following the hypertext links or clicking the hierarchical map.

The results presented in Section 3.3.1 and Section 3.3.2 suggest that the personalized learning system can match with the needs of both Holists and Serialists. Thus, Web-based learning systems should not only provide a simple keyword search and a hierarchical map that show a local picture, but also should make best of hypertext links and clickable hierarchical maps so that the needs of different cognitive styles can be accommodated.

The abovementioned findings suggest that Serialists and Holists show different preferences. More specifically, Serialists show positive reactions to the personalized scenario while Holists demonstrate equal reactions to the personalized scenario and the non-personalized scenario. Figure 11 proposes a framework, which summarizes the findings of this study.

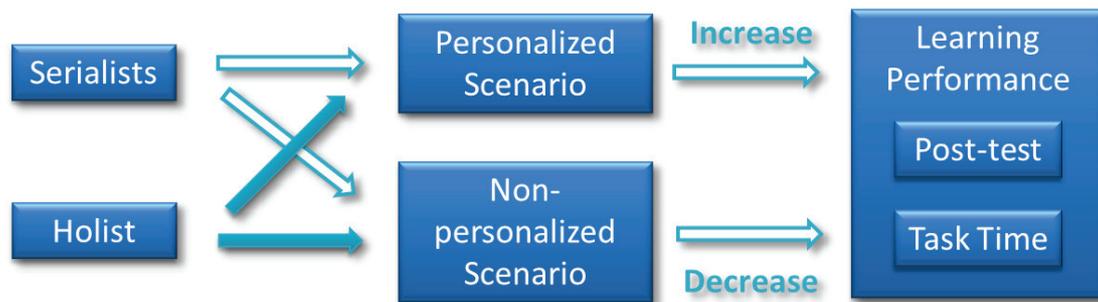


Figure 11. A framework based on the findings of this study.

#### 4. Conclusions

This study examines learners' reactions to the personalized scenario and the non-personalized scenario based on their prior knowledge. In addition, this study also investigates how Holists and Serialist react differently to these two scenarios. Our results demonstrated that the non-personalized scenario has negative effects on Serialists while Holists have potential to overcome difficulties that they meet in the personalized scenario. In brief, Serialists have relatively strong reactions to the personalized learning system based on prior knowledge. The findings described in this paper have shown the importance of understanding the effects of multiple human factors on personalization and non-personalization.

However, this was only a small-scale study. Further work needs to be undertaken with a larger sample to provide additional evidence. Another limitation of these studies is that this study only uses a k-means algorithm to conduct data analyses so further works can consider other data mining algorithms to discover more hidden relationships. Moreover, there is a need to consider other human factors in future. More specifically, this study investigate how cognitive styles affect learners' reactions

to a personalized learning system based on learners' prior knowledge. Further works can develop personalized learning systems on the basis of gender differences or cognitive styles and then examine how other human factors affect students' reactions to this personalized learning system. In addition, the results of such works could be integrated with those of this study to build robust user models for the development of effective personalized learning systems that can accommodate learners' individual differences.

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# A Surrogate Competition Approach to Enhancing Student Learning

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**Abstract:** Although competition is a powerful element to enhance students' motivation, but it still has negative influences on learning. To mitigate possible negative influences, some competition models have been proposed but they are merely suitable for anonymous and face-to-face learning contexts. To address such limitations, there is a need to explore other competition models. To this end, this study proposes the concept of surrogate competition, in which there is no direct competition between each student. Instead, each student has a substitute and the competition takes place between each substitute. Based on this rationale, a My-Pet-My-Arena system is developed and an empirical study was conducted to examine the effects of the surrogate competition. The results revealed that the My-Pet-My-Arena system could help students attribute competitive failures to the lack of effort.

**Keywords:** user-center design, competition, game-based learning

## 1. Introduction

Over the past decade, digital game-based learning has attracted more and more research interests. It is motivated by the fact that game elements are utilized to help students achieve their learning goals and improve their knowledge and skills [10]. Thus, game elements play an important role in game-based learning. In this vein, some game elements are investigated, such as control, fantasy, curiosity, challenge [23], imaginary, competition, uncertainty [21], goal, decision, cooperation, and competition [27]. Among these game elements, however, competition is seldom taken into account although it is promising and powerful [9]. A possible explanation is that competition emphasizes on the process of social comparison, in which students are exposed to numerous comparative information, which, in turn, influences students' self-concept [25]. Students might be damaged by negative influences, such as the lack of confidence [4] or lower self-efficacy [31] especially when students frequently fail in the competitions.

To mitigate the possible negative influences, previous works has proposed some mechanisms. One is anonymous competition, which provides a scheme to diminish negative impacts resulting from a face-to-face competitive context [34]. In anonymous competition, students' failure would not be revealed to the public so that the damage on students' confidence could be reduced. The other is group competition, in which competition is integrated into cooperative activities in small groups [30]. Since all of members in the group share the responsibilities for competition results, the possible negative influences are thus alleviated. Nevertheless, these mechanisms are applied in limited contexts. The anonymous competition is suitable for an anonymous-based distributed environment, rather than a face-to-face interactive environment, otherwise the effects of anonymity could not be activated. The group competition is also restricted to a group-based collaborative learning context, rather than an individual environment, otherwise the responsibilities could not be shared by group members.

To this end, there is a need to develop effective and flexible mechanisms to address these limitations. Consequently, this study proposes a game-based competitive mechanism, *surrogate competition*, in which there is no direct competition between each student. More specifically, each student has a substitute and the competition takes place between each substitute. Based on this rationale, this study develops a game-based learning system and conducts empirical studies to examine whether students could benefit from surrogate competition. More specifically, the empirical studies seek an answer for the research question of this study, i.e., “*how surrogate affects students’ view to the competition?*”.

## 2. Related work

Competition is regarded as a promising scheme for student learning [12] because competition could reinforce the goal structure of learning activities, which, in turn, enhances students’ motivation and academic achievement [16]. However, several researchers also indicate that the use of competition might bring negative influences [31], such as the lack of improving scheme [4] and high degree of stress [35].

This is because competition involves a social comparison process, during which participants are compared with each other [22]. Such acute comparison would affect students’ motivation, confidence, attitude, and belief in success [25]. Moreover, most of competitions are a zero-or-sum activity, in which one competitor wins the competition and the other, meanwhile, loses the competition. It implies that such competition always results in one competitor’s failure, which might cause some damages to the loser. Once the loser further attributes his/her failure to the lack of abilities, he/she might feel frustrated or even helpless in learning [11; 32; 33].

To alleviate these negative influences, several mechanisms are proposed, including personal improving space, computer-simulated agent, anonymous competition, and group competition. Their design rationales and relevant studies are listed in Table 1. The first two mechanisms emphasizes on positive belief while the last two mechanisms are concerned with negative effects. More specifically, the former makes learners understand that preparation would result in competition success, either via learning efforts by themselves or support from simulated agents. Conversely, the latter is to use anonymous or group protective mechanism to reduce possible negative impacts.

Table 1. Mechanisms to support competitive learning

| <i>Mechanisms</i>        | <i>Design rationales and function descriptions</i>  |
|--------------------------|---|
| Personal improving space | Offering students chances to prepare themselves before the competition takes place can help students easily understand that preparation is the best way to win the competition [5]. |
| Computer-simulated agent | Computer-simulated agents could scaffold students to improve their learning performance for competition, and even shaping their positive belief on effort [5].                      |
| Anonymous competition    | Anonymity could be as a protective mechanism for students who lose because their identity would not be revealed in public [36].   |
| Group competition        | Group competition could share the responsibility for failures, instead of taking the responsibility by an individual [17; 13; 30].  |

These competitive mechanisms are useful but they are only applied in limited contexts. For example, the personal improving space and simulated learning companions seem to be only suitable for individual learning; the anonymous competition and group competition appear to be suitable merely for anonymity-based and group-based settings. It

is difficult to apply them for more general learning contexts. A possible explanation resulting in these limitations lies within the fact that these mechanisms belong to direct competition: competitors compete against each other by their academic performance directly. In this vein, surrogate competition is thus proposed in this study based on the perspective of indirect competition: each student owns a surrogate, and the competition happens between these surrogates. This is because such surrogate competition offers more flexibility so that the competition between students can be more relaxed. Due to such benefits, we incorporate surrogate competition into a learning system and conduct two empirical studies to investigate whether such an approach is useful to students.

### **3. Surrogate competition**

#### *3.1 Design rationales of surrogate competition*

Figure 1 illustrates the differences between direct competition and surrogate competition. Unlike direct competition, where students use avatars to compete against each other, surrogate competition allows students to use surrogates on behalf of them to attend the competition. The main difference between direct competition and surrogate competition lies within the fact that the former involves the participation of two avatars while the latter is mediated by two virtual pets. More specifically, the direct competition involves students' self-image or self-identity to compete against each other. Conversely, the surrogate competition uses agents without self-image or self-identity to attend the competition, instead of themselves.

The aforementioned difference suggests that the surrogate competition is able to change students' views to competition. This is motivated by the fact that students often attribute their failures to the lack of abilities in the direct competition. Thus, the belief that they are "stupid" or "dumb" might be shaped, which, in turn, results in the negative influences. Nevertheless, the surrogate competition could help students shift their failure attributes from the lack of abilities to the lack of effort so that the negative influences might be less damaged.

Due to such benefits, surrogate competition is considered in this study. More specifically, virtual pets attend competition on behalf of students. Students play as the role of master so that effort in training virtual pets could be regarded as the most dominating factor to win in the competition. Therefore, these virtual pets could reflect students' learning status. This is achieved by using an Open Learner Model (OLM) where students' learning status is collected. The OLM is regarded as a manipulated model, which is accessible by students themselves so that they could observe, edit, and even negotiate with computers about their learning status [2; 3]. An additional benefit is that nurturing and caring virtual pets can facilitate human-computer interaction [18] because students play as their masters. By doing so, students could develop a long-term relationship with virtual pets, which could sustain their motivation, and further to facilitate interaction with their OLMs [7].

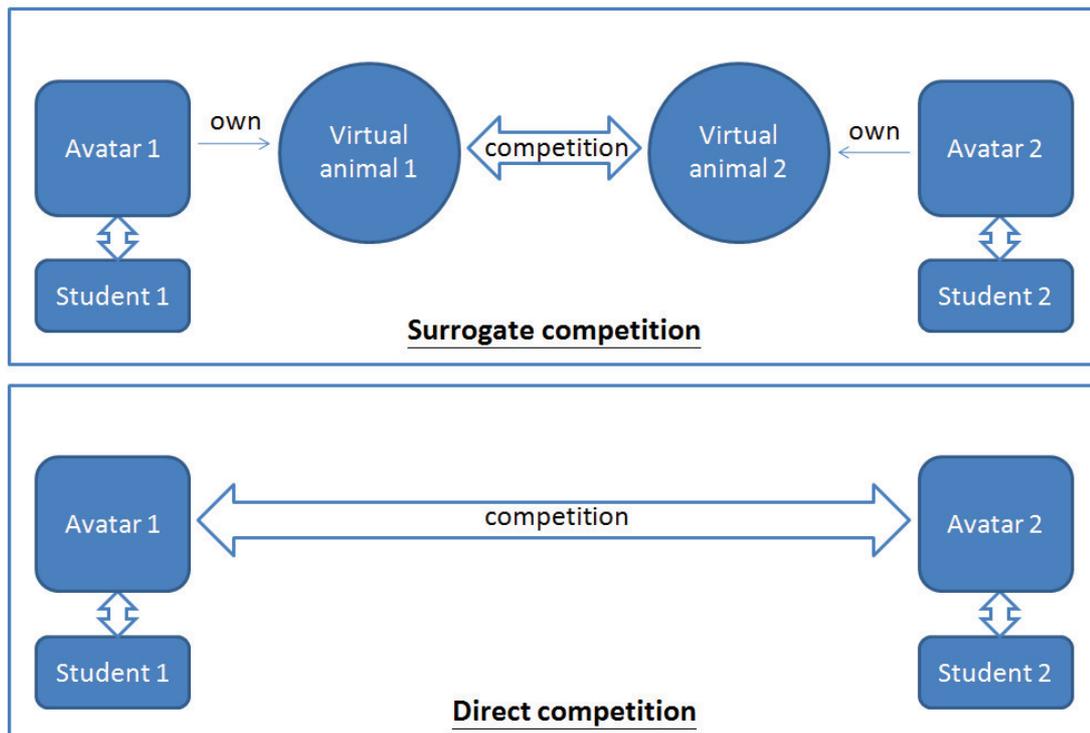


Figure 1. Concept of surrogate competition compared with direct competition

### 3.2 My-Pet-My-Arena system

#### 3.2.1 Three design perspectives on computer-human interaction

In addition to providing the benefits of surrogate competition, My-Pet-My-Arena system also brings several new design perspectives on computer-human interaction. How much learning effort students made is influential to their achievement [6; 29]. Thus, the first perspective emphasizes on students' effort-making belief. More specifically, virtual pets are used to enhance the computer-human interaction in the My-Pet-My-Arena system so that students can believe that there is a positive relationship between effort and success.

Subsequently, the second perspective lies within the fact that the My-Pet-My-Arena offers several "caring" functions for students to care their virtual pets. Such caring functions, which attach students' emotion, can sustain a long-term "master-and-pet" relationship. By doing so, students' motivation can be maintained, which, in turn, the computer-human interaction can be enhanced. The third perspective lies within the fact that virtual pets and OLMs are integrated as an information representation model within the My-Pet-My-Arena system. Through virtual pets, this model not only could actively remind students of what they have learned and have not mastered, but also be as a motivator to encourage students to interact with the My-Pet-My-Arena system.

#### 3.2.2 System development

The My-Pet-My-Arena system consists of four components. The first one is nurturing component, whose purpose is to develop students' attachment to the My-Pet. This intention can be realized by two functions: feeding, and caring. Regarding feeding, the system allows students to play as a "master", who is responsible for the My-Pet's satiated needs. In particular, the system presents them with a "satiated" attribute, which refers to whether the My-Pet is satisfied or not. By doing so, students can buy pets' food to feed the My-Pet.

Since students are as a giver and their My-Pets act as a receiver, the master-and-pet relationship would be established.

Regarding caring, the system aims to further enhance students' sense of being a "care-giver", who not only satisfies My-Pets' satiated needs, but also their healthy status. To this end, this system provides students with different pets' products. Students could use these products to look after their pets. Likewise, when students take good care of their pets, another "healthy" attribute would be presented. By doing so, students would experience how to take good care of their My-Pets, in which students' attachment to their pets can be enhanced.

The second one is learning component, which is the only part concerning Chinese idiom learning and My-Pet would offer students learning feedbacks (see Fig. 3). More specifically, to improve students' mastery of Chinese idioms, two functions are offered. The first one is to make students understand their learning progress. This function could be realized by presenting the mastery level for a specific Chinese idiom so that students know which topics they have mastered and have not mastered yet. The second one is to encourage students to improve their learning progress in a joyful way. To this end, this system offers a "pet-training" game context, in which students' effort made for improving mastery is further linked to the My-Pet's "effort" attribute. Thus, when students improve their mastery level, the "effort" value would be also promoted. Meanwhile, students can obtain virtual coins as rewards for buying pets' food and products. By doing so, students might feel that they are doing something helpful and meaningful to their My-Pet, instead of boring tasks.

In addition to the two components aforementioned, the My-Pet-My-Arena system contains the third component, i.e., the competition component. The intention of the competition component is to shape students' positive belief in effort-making. To this end, a pair-wise version of surrogate competition is developed so that the "effort" attribute could be regarded as a key factor that determines the competition result [8]. To realize this function, the rule of the surrogate competition is designed as several rounds, each of which a My-Pet can get an effort score based on the "effort" value. It implies that the more "effort" value the My-Pet has, the greater the chance that the My-Pet would win the competition. The surrogate competition continues by turns until one of the My-Pet which obtains the highest score wins the competition.

To further enhance students' sense of being a master, another component is developed. To this end, an avatar component is added in this version 2. This component is realized by offering the function of customizable avatars, in which students can choose virtual characters to adjust their appearances and decorations so that students feel that these avatars are on behalf of them within the virtual world. By doing so, students can see their avatars who play as the master to look after and train their My-Pets. Thus, the sense of being a master can be enhanced.

## **4. Experiment**

Although the results of Experiment One had showed that the My-Pet-My-Arena could enhance students' learning achievement, level of effort-making, and motivation, it was unclear how surrogate affects students' view to the competition when compared to other direct competition mechanisms. To address this issue, Experiment Two was conducted to investigate whether the surrogate competition could bring positive effects as direct competitions and meanwhile alleviate the negative effects.

### *4.1 Instrument*

#### 4.1.1 Two system versions

To answer the second sub-research question, how surrogate affects students' view to the competition, two systems were used in the experiment. One was My-Pet-My-Arena system, which is an example of surrogate competition. The other was My-Competition system, which is an example of direct competition. By comparing these two systems, we can identify the differences between direct competition and surrogate competition.

More specifically, the My-Pet-My-Arena system is developed to enhance participants' impression: they are playing as the role of masters. Although participants with this version owned their avatars (see Fig. 2a), they used My-Pets to reflect their learning status in Chinese idiom and dispatch their My-Pets to attend the surrogate competition on behalf of themselves (see Fig. 2a, 2b, 2c, &2d). Accordingly, they could prepare these surrogates, and even regard them as buffers of the competition. Due to this fact, the My-Pet-My-Arena system is classified as an example of surrogate competition.

Regarding the My-Competition system, all participants had avatars, which could be on behalf of the participants to participate in the competition. More specifically, the avatars reflect their OLMs in Chinese idiom (see Fig. 3a). Thus, participants could improve the status of Chinese idiom to strengthen their avatars (see Fig. 3b) so that they can compete against each other via their avatars (see Fig. 3c and 3d). Although participants also had My-Pets, these My-Pets could not do anything and just stay there. Thus, the participants still need to be directly involved in the competition. This is the reason why this system is categorized as one example of direct competition.

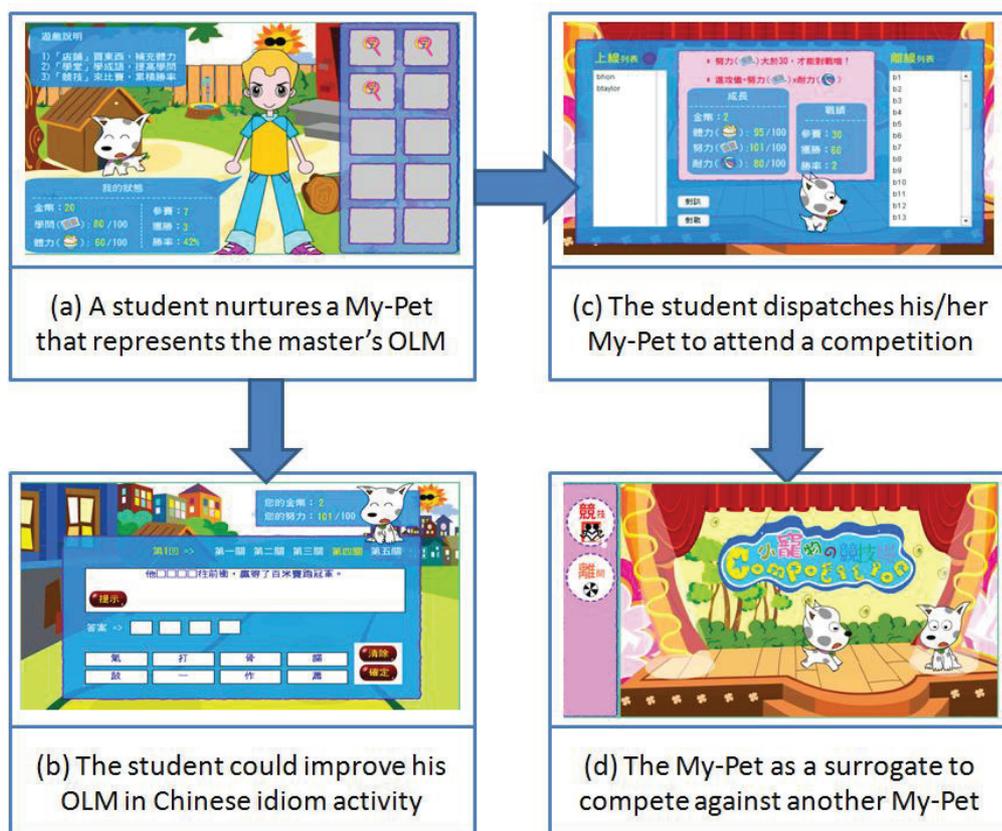


Figure 2. My-Pet-My-Arena system

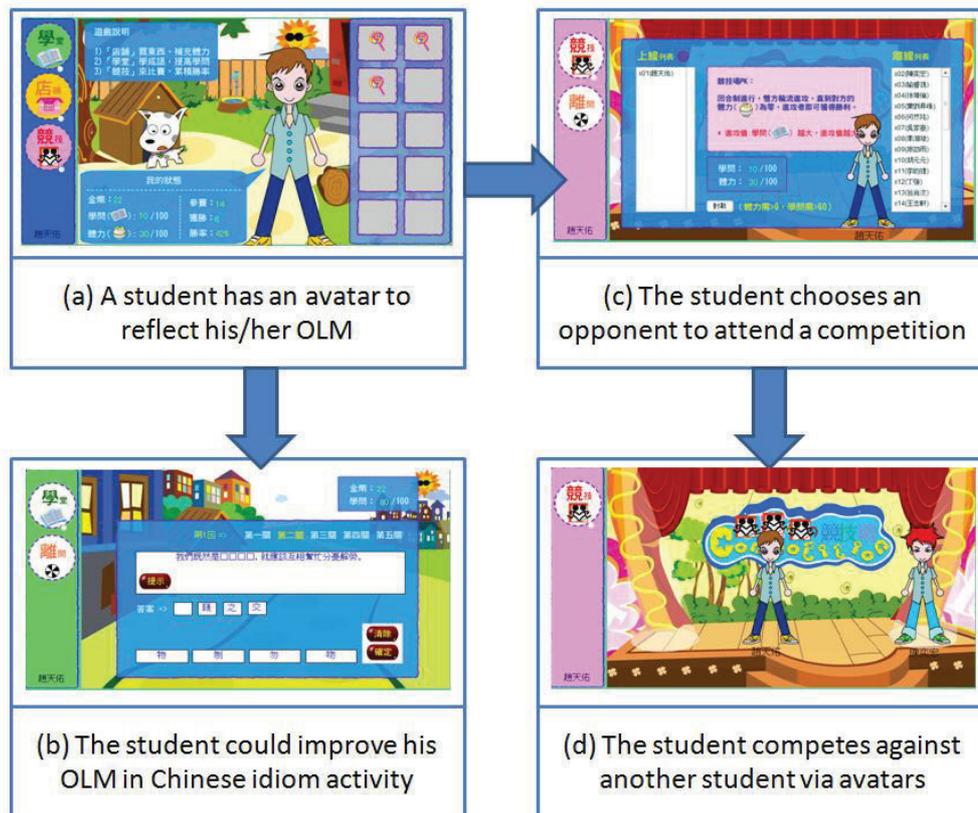


Figure 3. My-Competition system

#### 4.1.2 Attribution questions

As described previously, it is difficult to find a suitable questionnaire for surrogate competition. Thus, two attribution questions developed by the first author of this paper were used to measure students' attribution for the two groups. As shown in Table 2, one question was used when students win the competition, and the other one was used when students lose the competition. Each question provided four options and the participants chose the one matching with their thought.

Table 2. The two attribution questions

| The attribution question when winning   |
|---|
| I win the competition because (1) I have good luck (2) I spend more effort in learning Chinese idiom (3) I spend more effort in improving pets (4) I actually have better learning ability in learning Chinese idiom                  |
| The attribution question when losing  |
| I lose the competition because (1) I have no good luck (2) I do not spend more effort in learning Chinese idiom (3) I do not spend more effort in improving pets (4) I actually have worse learning ability in learning Chinese idiom |

#### 4.2 Participants

A between-subject quasi-experiment was used in the experiment and the participants consisted of two classes in an elementary school. The two classes are randomly assigned to two groups. Table 3 shows the different interventions and the distribution of participants in each group.

Table 3. The setting of the two groups

| Intervention |                        | Participants | Gender<br>(male: female) |
|--------------|------------------------|--------------|--------------------------|
| CG           | My-Competition system  | 29           | 19:10                    |
| EG           | My-Pet-My-Arena system | 31           | 17:14                    |

### 4.3 Procedure

Each group had two 50-minute sessions to use the system over the period of two weeks. At the beginning of the session, participants were told that they could freely use the system. This allowed participants to use the system in a natural condition. During each session, each participant approximately had six to ten times to attend the competition so that each one could have both winning and losing experience. This could be helpful to increase the validity of the collected data. During each competition, students were able to freely choose their opponents so that their choices were based on their preferences. In other words, students know whose avatars or pets they are competing against. At the end of each competition, both groups need to answer the attribution questions to express their attributions.

### 4.4 Data analysis

The independent variable of the experiment is the different settings of the two systems whereas the dependent variables of the experiment are participants' attribution when they won and lose the competition. To obtain a stable attribution, we calculate the mode (i.e., the number that appear most frequently) of their attribution as the primary attribution. For example, if a student's attributions are "luck", "luck", "luck", "ability", and "luck", the mode is "luck" because it appears four times. Besides, the mode could ignore the extreme or unstable data caused by participants' mistaken operation or other reasons.

In addition, participants' attribution should be stable during such a short period of time. Thus, when a participant's mode finally has multiple numbers, the used data analysis method is described as follows: (1) If the student's mode contains two numbers, it implies that the student has a *relatively* unstable attribution status. Since this is not an extreme case when compared to others, we still accept this case and count the two numbers, respectively. (2) If the student's mode contains three numbers or more, it implies that the student has a *very* unstable attribution status because there is a lack of careful consideration. Thus, we exclude these students from our data analysis. The Chi-square test, which is suitable to analyze categorical data, is further conducted to validate whether the result has significant difference.

### 4.5 Result and discussion

#### 4.5.1 Students' attribution when winning

This section presents the results of students winning the competition. Table 4 illustrates the final results of students' attribution, which exclude unstable cases described previously. Regarding CG, the number of students' attribution to effort made in learning (n=15) was relatively high than that to luck (n=9), ability (n=5), and effort in training pets (n=2). The result from a Chi-square test indicated that this difference was statistically significant ( $\chi^2 = 12.226$ , df=3, p<.01). Since the students in CG used the My-Competition system, it meant

that My-Competition system could facilitate students' major attribution to effort-making in improving learning.

One possible interpretation for this result was that the My-Competition system involved the representation of avatars to enhance their presence and participation. More specifically, because people tend to regard the behavior of their self-images as themselves [26], the avatars enhanced students' feelings of telepresence [28]. In particular, while the students could clearly observe what they did and what the consequence was, the cause-and-effect relationship between effort-making and the competitive success was enhanced, which, in turn, fostered the attribution to their effort in improving learning. To our surprise, two students in CG attributed their success to effort in training pets. Although students owned My-Pet in the My-Competition system, the My-Pet could not do anything and stay there. Thus, such a choice, which is a very small portion (n=2), might be due to the attraction of pet animation or unserious consideration. To this end, there is a need to verify this issue with further works.

Table 4. Students' attribution between two groups when winning

|    | Luck    | Effort             |              | Ability |
|----|---------|--------------------|--------------|---------|
|    |         | Improving learning | Training pet |         |
| CG | 9 (29%) | 15 (48%)           | 2 (7%)       | 5 (16%) |
| EG | 5 (14%) | 11 (29%)           | 16 (43%)     | 5 (14%) |

Regarding EG, the number of students' attribution to effort made in training pets (n=16) was relatively high than that to effort in improving themselves (n=11), luck (n=5), and ability (n=5). This difference was statistically significant ( $\chi^2=9.162$ ,  $df=3$ ,  $p<.05$ ). Since the students in EG used the My-Pet-My-Arena system, it implied that My-Pet-My-Arena could facilitate students' major attribution to effort-making, instead of other causes (i.e., luck and ability). One possible interpretation for this result was that the My-Pet-My-Arena system enabled students to play as the role of pet-master, which further enhanced students' sense of being as well as the responsibility of taking care of the pets. This is the reason why they chose this attribution. In addition, some students might be aware of the fact that spending efforts in training pets can actually improve their learning status. This might be the reason why some of students attributed their success to the effort made in improving learning.

Furthermore, when comparing the students' attribution between CG and EG, it could be found that the major attributions in CG were effort in improving learning (48%) and luck (29%), whereas the major attributions in EG were effort in training pets (43%) and effort in improving learning (29%). A Chi-square test further indicated that this difference was statistically significant ( $\chi^2=12.213$ ,  $df=3$ ,  $p<.01$ ). Such a difference implied that the students who used the My-Pet-My-Arena system tended to attribute their competitive success to their effort (72%=43%+29%, in improving learning and in training pets). Conversely, the attribution of the students using the My-Competition system focused on effort (48%, in improving learning) and luck (29%). In other words, My-Pet-My-Arena system could ensure that most of students attributed their competitive success to effort.

A possible reason was that the difference resulted from the different system instruments: My-Competition system only used the avatars whereas the My-Pet-My-Arena system used both the avatars and virtual pets. Previous studies had indicated that the use of avatars could be helpful to self-disclosure [15] because avatars can facilitate the linkage between users and onscreen characters, which, in turn, increased the sense of participation [20]. Nevertheless, the difference between these two systems lie within the fact that My-Pet-My-Arena system also used virtual pets to promote their identity of playing as the role of master, which further motivated students to do something for their pets.

Consequently, the My-Pet-My-Arena system had more influences on students' positive attribution to effort than My-Competition system.

#### 4.5.2 Students' attribution when losing

The results of students losing the competition are illustrated in Table 5, which excludes unstable cases. Regarding CG, the number of students' attribution to effort made in improving learning (n=18) was relatively higher than that to luck (n=8), ability (n=4), and effort in training pets (n=4). A Chi-square test further showed that this difference was statistically significant ( $\chi^2=15.412$ ,  $df=3$ ,  $p<.01$ ). Since the students in CG used the My-Competition system, it meant that most of students who used the My-Competition system majorly attributed their competitive failure to their effort made in improving learning. This result was similar to that in students' success attribution. One possible explanation was that the My-Competition system enabled the embodied avatars to stand for students' presence and participation. In particular, students could clearly observe what they did and what the consequence was, which further reinforced the positive relationship between the effort and competitive outcomes (i.e., whatever they won or failed in the competition). Thus, students tended to attribute the competitive failures to their effort in improving learning. Beyond our expectation, four students in CG attributed their failures to effort in training pets, which should not appear in the My-Competition system because the My-Pet could not do anything and just stay there. Such a choice from a very small portion of students might be due to the attraction of pet animation or unserious consideration, which needs to further verify in further works.

Table 5. Students' attribution between two groups when losing

|    | Luck    | Effort             |              | Ability |
|----|---------|--------------------|--------------|---------|
|    |         | Improving learning | Training pet |         |
| CG | 8 (23%) | 18 (53%)           | 4 (12%)      | 4 (12%) |
| EG | 9 (23%) | 10 (26%)           | 17 (43%)     | 3 (8%)  |

Regarding EG, the number of students' attribution to effort made in training pets (n=17) was relatively higher than that to effort in improving themselves (n=10), luck (n=9), and ability (n=3). This difference was statistically significant ( $\chi^2=10.128$ ,  $df=3$ ,  $p<.05$ ). Since the students in EG used the My-Pet-My-Arena system, these results implied that the My-Pet-My-Arena system could foster students' major attribution to effort-making (both in training pets and in improving themselves), instead of other causes (i.e., luck or ability). The result was also similar to that in students' success attribution. One possible reason was that the students' identity within the My-Pet-My-Arena can be enhanced so as to be a good master and be more responsible for their pets. Thus, they tended to attribute their competitive failures to effort made in training pets. In addition, some students might be aware that the purpose of training pets is actually to improve their learning status. This might be why some of students attributed their failures to the effort made in improving learning.

Moreover, when further comparing the students' attribution between CG and EG, it could be found that the major attributions in CG were effort in improving learning (53%) and luck (23%), whereas the major attributions in EG were effort in training pets (43%) and efforts in improving learning (26%). A Chi-square test indicated that this difference was statistically significant ( $\chi^2=10.241$ ,  $df=3$ ,  $p<.05$ ). It implied that the students with the My-Pet-My-Arena system tended to attribute their competitive failure to their effort (69%=43%+26%, in improving learning and in training pets). By contrast, students using the My-Competition system emphasized on the attribution to effort (53%, in improving

learning) and luck (23%). In other words, My-Pet-My-Arena system allowed most of students to attribute their competitive failure to effort, instead of other factors.

A possible interpretation was that the difference in students' attribution resulted from the different system instruments (i.e., My-Competition and My-Pet-My-Arena). More specifically, although the two systems involved the use of avatars, My-Pet-My-Arena system used virtual pets to promote their identity of playing as the role of master, which further reminded students of being responsible. Previous studies have found that pets play a significant role in children's lives [19], and it is children's instinct to approach these pets, taking good care of them [24]. This might be the reason why the existence of the pets in EG could facilitate students' failure attribution to effort in training pets, instead of another uncertain factor, i.e., luck attribution in CG.

## 5. Conclusion

With respect to the second sub-research question—*how surrogate affects students' views to the competition?*, Experiment Two was conducted to compare the differences between My-Pet-My-Arena and a direct competition system. The results revealed that the My-Pet-My-Arena system could facilitate most of students to attribute their competitive outcomes to the effort that they put, rather than other factors, no matter when they win or lose in the competition. However, due to the limitations of this study, further studies are required. In particular, although this study showed positive effects of surrogate competition on students, it was merely a short-term study. There is a need to examine the long-term effects of surrogate competition in the future.

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