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EVALUATIONS TO THE GAMIFICATION EFFECTIVENESS OF DIGITAL GAME-BASED ADVENTURE EDUCATION COURSE - GILT

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Keywords: Adventure education, Digital game-based learning, Problem-solving, Interpersonal relationship.

This study aimed to design a digital game-based adventure education (GILT) course for team-building purposes. The six traditional activities chosen from adventure education were developed into six digital games and were integrated as a coherent face-to-face interactive course. In the course, participants can enhance interpersonal interactions, learn the themes and issues adventure education attempts to deliver, and train their problem-solving abilities with digital games. Thirty teenagers aged between 19 and 25 in Taiwan were invited to participate the course. Four aspects were evaluated with questionnaire in this study and the results show that the participants have positive attitudes toward the learning themes of adventure education, problem-solving abilities, interpersonal interactions, and game effectiveness about the six digital games in the GILT course.

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1 Introduction

In the past, adventure education courses were implemented in physical forms indoors as well as outdoors. In the courses, participants were divided into groups which purpose was to bring participants together and become great companions. Through reflections after each activity in the course, participants learn the lessons each activity meant to deliver such as skills about human relationship, leadership, or communication. After that, the participants can apply what they learned in the course to their daily lives. However, some traditional adventure education activities were difficult to implement due to environmental limitations, high requirements to equipment setup, or unstable weather conditions. For now, it is rare to find studies focusing on developing those traditional activities into digital forms or on investigating the possibilities of technology implementation.

Nowadays, teenagers are easily involved in digital games. They also like to express their thoughts, feelings, and emotions along with the digital games. The gamification to issue discussions of all kinds can be an innovative approach to reach the goal. On the other hand, the attendance and participation to the traditional adventure education activities are a little lower than before. Therefore, this study aimed to develop a digital game-based adventure education course, GILT (Fig. 1), which arranged adventure education activities with digital games based on Tuckman's model of team development stages embedding four main elements, game (G), interaction (I), learning (L), and team-building (T). The goal is to let adventure education activities to be gilted with fun, issues learning, and reflections. In the process, all groups would learn to make team-building process more efficient and become high performance groups. This study tries to investigate two research questions: 1. Do teenagers learn adventure education themes, problem-solving skills, and positive interpersonal interactions throughout the GILT course? 2. What are teenagers' attitudes toward the digital games in the GILT course?

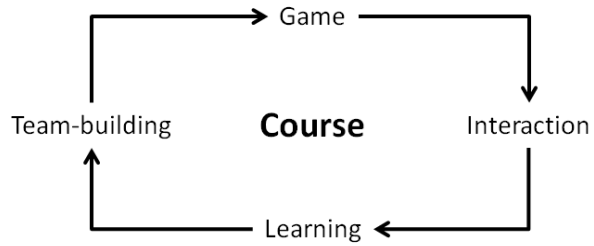

Fig. 1 - The framework of GILT course

2 Literature Review

2.1 Digital adventure education game

Adventure education refers to an activity or a series of activities with specific learning themes for the participants to learn through the process as well as the reflection sessions. It is supposed to allow them to think and internalize the lessons learned in the activities, and use them in the practices of everyday life. The activities are varied, such as games, arts, sports, music, rock-climbing, or any sorts of indoor or outdoor activities (Ewert, Sibthorp & Sibthorp, 2014). In Taiwan, the adventure education practices are mostly rope-based or team-building oriented activities that train participants cognitive abilities or thinking skills, as well as life-long learning themes such as leadership, communication, problem-solving, cooperation, interpersonal interactions, etc. There have been numerous well-developed activities and courses (Hsieh, Wang & Chuang, 2008), but have not been any practiced with digital games.

Digital game-based learning (DGBL) has become a popular learning approach in the recent years. The purpose is to use digital games to enhance participants' learning effectiveness, problem-solving skills, and interpersonal interactions (Kiili, 2005). More recently, a number of studies have further confirmed the existence and complex nature of DGBL; however, there are still few studies mentioned the integration of counseling or adventure education. Hsu and Shih (2013) worked on one instance that they called digital game-based counseling (DGBC) who tried to evaluate the effectiveness of digital games as tools for individual counseling and adventure education. The results confirmed that DGBC can have the same counseling effectiveness as the traditional face-to-face counseling when they have appropriate design and practice. The paper had shown considerable benefits of DGBC, but had not investigated the gaming process in terms of team-building and other interactions. Therefore, this research attempts to evaluate the process.

So far, teachers and facilitators for adventure education attempt to develop tools and mechanisms to add on the physical activities, but many times encounter problems in tracking members' interactions. For this reason, digital technology can be a nice supplement which not only brings up participants' motivations but also offers sustainment tools for making gaming records. Facilitators can use the gaming records for the discussion in the reflection sessions, and lower down participants' mental pressures to interact with the facilitator and peers. The essence of the GILT course would then be easier to be induced and deliver to the participants.

2.2 Game-based problem solving

Problems usually happened when the individual encounters situations that were different from expectations; in these situations, individuals would have to take actions to reach the status of completion or success. This problem-solving ability can be trained in many ways such as courses, activities, and web training (Belski, 2011). There were studies that had proved problem-solving ability can be trained through appropriate instructional design of digital games; at the same time, digital games can enhance learning effectiveness, learning motivation, and learning attitudes (Shih *et al.*, 2010). Hou and Li (2014) used Kiili's (2007) problem-based gaming model to design problem-solving digital games to teach participants about computer assemblies, and had obtained positive results. Hwang, Wu, and Chen (2012) developed a multi-player chessboard game that required players to collect resources and answer questions as they move along. Although problems were defined in various ways in different studies, they were generally categorized into stages such as identifying problems, defining problems, searching for resources, deciding solutions, taking actions, and evaluating results. In this research, participants need to go through problem-solving process by immersing in the digital game situation and completing tasks that require high-level mental skills such as thinking, analyzing, and synthesizing.

Bransford (1984) proposed problem-solving IDEAL model defining five stages of the problem-solving procedure, which includes (I) identify problem, (D) define problem, (E) explore alternative solutions, (A) apply solutions, and (E) effects of solutions. The model is often used to evaluate participants' problem-solving process and effectiveness (Lamm *et al.*, 2012). Other than that, problem-solving attitudes are also an important part of the problem-solving abilities. Heppner and Petersen (1982) stated three aspects of problem-solving attitudes including problem-solving confidence, approach avoidance style, and personal control. Thus, the problem-solving inventory (PSI) was widely used to evaluate problem-solving effectiveness (Bansal, 2014). However, the two evaluation methods have not been used in the related studies of digital games. It would be an innovative trial in this study.

2.3 Interpersonal relationships

Interpersonal communication is created by human interactions between each other; the communication effectiveness would influence the establishment of interpersonal relationships. Benjamin (1974) proposed an interpersonal relationship model called Structural Analysis of Social Behavior (SASB) which sees various interpersonal behaviors to be "focus on others", "focus on self",

and "introjective focus." It investigates people's adjustments of interpersonal interactions from active, passive, to introjective focus. It is developed into evaluation tools such as scales and questionnaires (Benjamin, 2011). It is often used in analyzing interpersonal relationship issues in the field of counseling, medical treatment, business management, and family structure.

Games can increase positive human interactions; the more the participants interact in the game, the more they can be immersed in the situation (Lo, 2008). The interactions come from the game rules that force the participants to interact with others in order to reach the game goals. Therefore, activities are the heart of adventure education that aimed to increase participants' interpersonal relationship (Neill & Dias, 2001).

3 Design of GILT course

The adventure education activities were adopted from a book that prescribed 150 experiential games for learning (Hsieh, Wang & Chuang, 2008); six of them were chosen to be made into digital games, including Polar Bears and Holes, Cooperative Puzzle, Chessboard Maze, Moon Ball, Balance Board, and Calculator. All these activities have certain difficulties in carrying them out in the physical form such as large space requirements, and complex arrangements or tools. All adventure education activities designed in the GILT course have reflection sessions conducted after each game so that the participants can get to know the connotations of the activities and understand the themes the activities aim to carry out. There are pre-determined themes for every stage of the course which were formulated using Delphi technique (Wu, Hsu & Shih, 2012). In the study, a detailed account of 12 themes of adventure education were generated and categorized into external and internal motivations (Table 1). External motivations include leadership, communication, cooperation, support, responsibility and active; and internal motivations include reflection, trust, thinking outside the box, empathy, dare to change, and handle frustration. GILT course was conducted with groups of five members. The course was designed based on Tuckman's model of team-building stages. Six digital games were arranged into the team development stages in accordance with the features of every stage. With the six digital games in five stages, group members were trained to enhance their problem-solving abilities, and have positive interpersonal interactions.

Table 1
SIX GAMES OF GILT COURSE

Stage	Forming	Storming	Norming	Performing	Adjusting
Digital Games	Polar Bears and Holes	Cooperative Puzzle, Chessboard Maze	Moon Ball	Balance Board	Calculator
External Motivation Themes	communication, cooperation	leadership, communication, cooperation, support, responsibility, active	leadership, communication, cooperation, active	leadership, communication, cooperation, support, responsibility, active	leadership, communication, cooperation, support, responsibility, active
Internal Motivation Themes	reflection, trust, thinking outside the box, dare to change	reflection, trust, thinking outside the box, empathy, dare to change, handle frustration	reflection, trust, handle frustration	reflection, trust, handle frustration	reflection, trust, empathy, dare to change, handle frustration
Game Forms	Tablet	Desktop/Kinect	Desktop	Kinect	Tablet
Numbers of Players	Single	Multi-Player/ Single	Multi-Player	Multi-Player	Multi-Player

The six digital games were developed into high simulations and with cross-platform functions to present the different themes embedded in the original activities. Unity3D was chosen as the development tool which had high simulation, particle system, physical simulation, and cross-platform functions (PC, IOS, Android, XBOX360, Wii, and Web). We developed the six digital games into three platforms: desktop, tablet, and kinetic. The details of the six games are explained as follows.

3.1 Multi-player games: Cooperative Puzzle, Moon Ball

Cooperative Puzzle and Moon Ball are played by five people as a team. The mechanism of network connection is based on the documents of Unity official tutorial. For connection matter, one computer acts as the server and the other four computers act as clients. For network connections, all game objects which need network synchronization have to increase the NetworkView component.

In Cooperative Puzzle (Fig. 2, Left), each member gets three puzzle pieces out of total of fifteen. All five members in the group must cooperate to compile five equal-size squares with the fifteen puzzle pieces to complete the task. Members can swap puzzle pieces with other members without talking to each other. In the game, members can only give out puzzle pieces but not request from others. The purpose of Cooperative Puzzle is to require participants to

observe others' needs and give out what they have in order to achieve the group success. They would discover their own roles in the process. In order to document the exchange process between the members, the digitization of the game becomes very helpful for the facilitator to retrieve the records for the reflection session. In the game interface, the center window shows the player's puzzle table, and the other members' puzzle tables were presented in the other four windows in the four screen corners respectively. With network connections, the process of moving puzzle pieces between the five members was recorded immediately.

In Moon Ball (Fig 2, Right), the ball would be patted by members to keep it in the air for as long as possible. Anyone was restricted from patting the ball twice in a roll. If the ball touches the ground, the game would restart and the time would be recounted. The timer is shown on the screen. In fifteen minutes, the longest gaming time would count toward the final achievement of the group. The purpose of Moon Ball is to train members to use strategies to cooperate with others. The traditional activity of Moon Ball is implemented in the outdoors and requires a wild open field to perform. The environmental requirement is always a challenge for the facilitator to implement. Therefore, it is a game appropriate to be developed into digital game. With high simulations in Unity3D, four gaming scenes were designed to create various gaming atmospheres, such as snowfield, paddy field, forest, and beach.

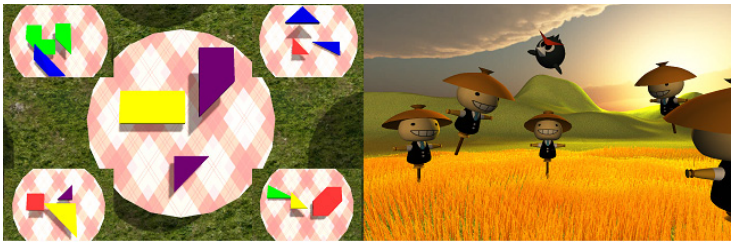

Fig. 2 - Multi-player games: Cooperative Puzzle; Moon Ball.

3.2 Tablet Games: Polar Bears and Holes, Calculator

Tablets have the advantages of small equipment volumes and easy to carry. In the games Polar Bears and Holes, as well as Calculator, group members have to communicate frequently to reach the game goals. For the purposes, the two games are developed into tablet games and the members would play it face-to-face and discuss with each other throughout the game.

Polar Bears and Holes (Fig. 3, Left) begins with a story describing the perceived number of polar bears and holes in the north pole, and brings out the

mission of figuring out the mathematical logic behind the story. The facilitator threw the dices three times to give hints to the members. Next, the members observed, discussed, and clicked the correct answers three times to see if they can land on the correct logic. In the traditional activity, it is hard for the big group members to see the tiny dices on the facilitator's table, and understand the story without images. Thus, the development of the game aimed to enhance the context of the story, and use personal tablet PC as the tool to allow everyone to participate the game. Once the member gets the correct answers three times in a roll, they complete the task of the game. After the game, the information of the gaming process would be provided to the facilitator.

In Calculator (Fig. 3, Right), thirty ladybugs marked from numbers 1 to 30 were placed in a garden, and all the five members in the group would have to catch the ladybugs in sequence in their highest speed. If the gaming rules were violated, 5 seconds of gaming time would be added as the punishment. There were four chances for the groups to achieve the highest score. In the traditional activity, Calculator is an activity which requires a wild open field for the participants to run back and forth. As Calculator was developed into multi-player tablet game, members can discuss face to face in a small circle, discuss the strategies to click the ladybugs in turns to reach the highest speed. After the game, the processes of every trial would be recorded and presented to the facilitator for the reflection session.

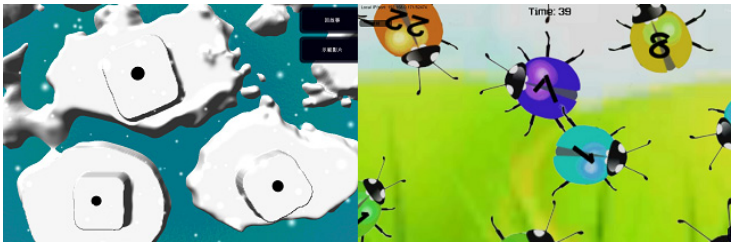

Fig. 3. Tablet Games: Polar Bears and Holes; Calculator.

3.3 Kinetic Games: Chessboard Maze, Balance Board

Motion-sensing technology mainly detects users' skeleton and body movements with in-depth imaging technology. Learning by doing of adventure education was practiced with digital games as the users' bodies are their game consoles. Chessboard Maze and Balance Board are developed into kinetic games which use motion-sensing technology of Kinect to connect to OpenNI. The two games are developed by motion detection plugin of Zigfu.

Chessboard Maze (Fig. 4, Left) was played by one player at a time, and

all members take turns to try the challenges. Players need to go through the 4x5 chessboard full of landmines to reach the other side of the board. There is only one correct path. Once someone takes the wrong path, he must start over again. Every failure leads to score deduction. Chessboard Maze aimed to make members learn how to perform strategies together as a team through their co-experiences by breaking fixed conceptions, challenging obstacles, and going through trial-and-errors. The traditional activity of Chessboard Maze also requires a wild open space. The digitalization of the game can not only allow small space gaming, but also to present the explosion effects when members step on the landmines. In the kinetic game, members' body movements were detected by Kinect sensor. There are eight kinds of movements including front, back, left, right, left front, left back, right front, and right back, to let users go through the maze.

Balance Board (Fig. 4, Right) requires three people to play together. One member keeps balance of the board and the other two keep pushing the board upward on the two opposite sides until the board reaches the end. The purposes of Balance Board are to increase members' cooperation strategies and face the challenges. Traditional activity of Balance Board has to be implemented at a professional outdoor adventure education space with high-altitude equipment with security assurances. There should be safety officers to assist the members. It is time, space, and labor consuming to conduct the physical activity. For this reason, the digitalization of Balance Board solved all these problems. In this game, a member acts the adventurer standing on the board moving through the canyon crevices. Through this game, members can experience the fear and pressure of heights and losing balance.

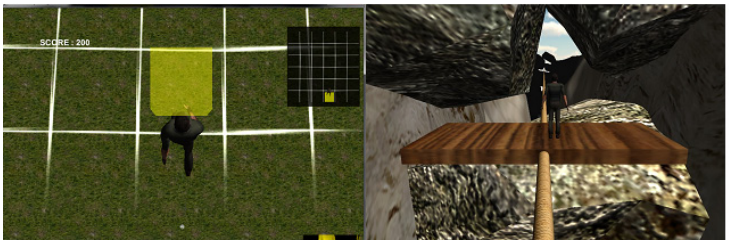

Fig. 4 - Kinetic Games: Chessboard Maze; Balance Board.

4 Research Methods

4.1 Research Design

The experiment was conducted in three days with six hours a day; two groups in a day, with five members in each group, led by a facilitator to imple-

ment GILT course. Before the course, participants had to fill out the pre-questionnaire to know their prior knowledge of the themes of adventure education, problem-solving, and interpersonal relationship. After course, the participants filled out the post-questionnaire about GILT course effectiveness.

In this learning experiment, six digital games were included in the GILT course that teenagers were suitable targets for. Thus, thirty college students aged between 19 and 25 in Taiwan were invited to participate and randomly distributed into groups. There were twelve males and eighteen females, and effective response rate is 100%.

4.2 Questionnaire on GILT Course Effectiveness

The purpose of this paper was to investigate participants' learning effectiveness and game satisfactions after GILT course. The questionnaire on GILT course effectiveness in this study was adopted from the study of Hsu and Shih (2013) which has four parts: themes of adventure education, problem-solving, interpersonal relationships, and game satisfactions. The credibility value of the questionnaire is Cronbach's α.70. Coefficient of internal consistency is.90. There are total of 53 questions. Six-point Likert Scale was used, with 6 to be "strongly agree", 5 to be "agree", 4 to be "somehow agree", 3 to be "somehow disagree", 2 to be "disagree", 1 to be "strongly disagree".

The first part, themes of adventure education, has 14 questions. Twelve themes of adventure education generated by Wu, Hsu, and Shih (2012) were used. There are two factors. External motivation connotations include leadership, communication, cooperation, support, responsibility, and active. Internal motivation connotations include reflection, trust, thinking outside the box, empathy, and dare to change, handle frustration. Each connotation has one to two questions.

The second part, problem-solving abilities, includes problem-solving procedure and problem-solving attitude with total of 16 questions; 2 questions for each following aspects. Problem-solving procedure includes aspects such as identify problem, define problem, explore alternative solutions, apply solutions, and effects of solutions in IDEAL model (Bransford & Stein, 1984); and problem-solving attitude includes aspects such as problem-solving confidence, approach avoidance style, and personal control (Heppner & Petersen, 1982).

The third part, interpersonal relationship, has total of 15 questions which was mainly referred to the positive and passive factors of human interactions in Benjamin's SASB (1974). There were 9 positive questions and 6 passive questions in total.

The forth part, game satisfactions, has 8 questions regarding interactivity, guide, enjoyment, challenge, and simulation.

5 Research Results

5.1 Themes of GILT course

The t-test results regarding to the themes of GILT course are shown in Table 2. The results showed significant differences (t=-2.549*, *p*=.016) between the pre-test and post-test that GILT course had positive learning effectiveness for teenagers.

Table 2
T-TEST RESULTS OF THE THEMES OF GILT COURSE

TOPIC		N	Mean	SD	t	p
Themes of GILT course	Pre-test	30	4.95	.47	-2.549*	.016
	Post-test	30	5.50	1.36		

*p<0.05, **p<0.01

The results showed that items of external motivation connotations including leadership, communication, support, and active, as well as internal motivation connotations including trust, thinking outside the box, and handle frustration, had significant differences between pre-test and post-test. From the results, we could find that participants were willing to face the difficulties with their members when they faced problems (Q1, t=-4.626***, p=.000). They were willing to increase positive interactions, such as support and help each other (Q2, t=-2.538*, p=.017), build great cooperation (Q5, t=-3.500**, p=.002), and try hard with members actively (Q7, t=-3.117**, p=.004). They help each other even though facing difficulties (Q9, t=-2.192*, p=.037). In the games, they accepted failures and would try harder to achieve the goals (Q13, t=-2.845**, p=.008). After facing failures, they would try different ways and think outside the box to solve problems (Q12, t=-2.841**, p=.008).

On the other hand, cooperation (Q3; t=-1.408, p=.169, Pre-m=5.53, Post-m=5.70), responsibility (Q6, t=-1.153, p=.258, Pre-m=5.33, Post-m=5.50), reflection (Q8, t=-1.15, p=.258, Pre-m=5.20, Post-m=5.37), empathy (Q11, t=-1.610, p=.118, Pre-m=5.10, Post-m=5.37), and dare to change (Q14, t=-.812, p=.423, Pre-m=5.17, Post-m=5.30), did not reach significant differences between pre-test and post-test. Ceiling effects were seen in these items since all the means were above 5 in the pre-tests already. Most participants thought that group members had to cooperate with each other to reach group goals, have responsibility, and stand in other's shoes. However, the question "I think I can solve game missions without teamwork." had not reached significant difference and had no ceiling effects (Q4, t=-.421, p=.667, Pre-m=4.53, Post-m=4.67)

since not all participants thought that cooperation was necessary for success. From the gaming process video records of the GILT course, Group 2, 3, and 6 finished the game Calculator and got the highest scores with only one member playing the game. It might also be the reason that the facilitator did not guide the reflection of Calculator game toward the direction of cooperation.

In the aspect of thinking outside the box, the question "I think thinking outside the box is helpful for problem-solving" had reached significant difference (Q12, t=-2.841**, p=.008), but "I can try to think outside the box when I solve problems." had not (Q10, t=-1.904, p=.067, Pre-m=4.53, Post-m=4.87). Most members thought thinking outside the box was helpful for problem-solving. Nevertheless, it takes times to train the skills and habits. In the course, most participants' perceptions could be changed, but their behaviors would not have significant difference in a short time.

5.2 Problem-Solving Abilities

The t-test results regarding to the problem-solving abilities are shown in Table 3. The results showed that problem-solving ability of the participants had significant difference after taking the GILT course (t=-7.754***, *p*=.000). Most group members were willing to consider and evaluate the best solutions thoroughly and solve the problems calmly and rationally.

Table 3
T-TEST RESULTS OF PROBLEM-SOLVING ABILITIES

TOPIC		N	MEAN	SD	T	P
Problem-solving Ability	Pre-test	30	4.55	.51	-7.754***	.000
	Post-test	30	4.92	.46		

*p<0.05, **p<0.01

In the "identify problems" stage, the question "I could find many causes when a problem happened" had not reached significant difference, but ceiling effects were seen since the means of all the items in this stage were all above 5 in the pre-tests already (Q1, t=-1.649, p=.110, Pre-m=5.10, Post-m=5.30). The question "I could identify the correct problem in many possible conditions" had significant difference (Q2, t=-2.340*, p=.026). Participants thought they could take all kinds of possible causes for the problems into considerations, make correct judgments in the game, and apply this skill in life after the GILT course.

In the "define problems" stage, the question "I could try to figure out the solutions in different means" (Q3, t=-1.683,.103, Pre-m=4.93, Post-m=5.20) and "I could define the final problems in many possible options" (Q4, t=-.895, p=.378, Pre-m=4.80, Post-m=4.97) had not reached significant difference with

ceiling effects. The results showed that participants could use different ways to think through solutions and figure out the best one in the GILT course.

In the "explore alternative solutions stage", the question "I could compare the different difficulty levels of the solutions" had not reached significant difference with ceiling effects (Q5, t=-.254, p=.801, Pre-m=5.07, Post-m=5.10). The question "I could compare the possibilities of success" had reached significant difference (Q6, t=-2.276*, p=.030). The results showed that participants could make comparisons of the feasibility of the solutions and solve the problems with the best solution after GILT course.

In the "apply solutions" stage, the question "Once deciding the solution, I could implement it step by step" (Q7, t=-3.395**, p=.002) and "Once deciding the solution, I could implement it thoroughly" (Q8, t=-2.065*, p=.048) had reached significant difference. The results showed that participants could implement progressively and systematically the solution which the group members decided in the GILT course.

In the "effects of solutions" stage, the question "If the results of solutions were not as expected, I would rethink what the problem was" had reached significant difference (Q9, t=-3.458**, p=.002). The question "Once the results were still not as expected, I would find other solutions for the problem" had not reached significant difference with ceiling effect (Q10, t=-1.651, p=.109, Pre-m=4.97, Post-m=5.20). The results showed that participants could be trained to rethink, discuss, and review to find the crux of the problems when they were confronted with bad solutions. Then, they were able to figure out better solutions.

In the "confidence to face problems" aspect, the question "I thought I had the ability to solve problems" had not reached significant difference with ceiling effect (Q15, t=-1.393, p=.174, Pre-m=4.47, Post-m=4.73). The question "I believed I could solve the problems even though that were difficult." had reached significant difference (Q16, t=-3.379**, p=.004). Participants had confidence to solve problems even when they were difficult in the GILT course.

In the "approach avoidance style" aspect, the question "Once having a problem, I would continue until confident to the feasible method" (Q12, t=-1.884, p=.070, Pre-m=4.63, Post-m=5.03) and "While facing difficult problems, I am willing to solve it without having bad feelings" (Q14, t=.983, p=.334, Pre-m=2.97, Post-m=3.33) had not reached significant differences; but the mean of post-test was higher than pre-test. After the GILT course, participants expressed that they would think through the solutions when they faced problems. Once the solution was confirmed, they would execute it. Even when it was a difficult problem, they would be willing to try to solve it without showing bad emotions.

In the "personal control" aspect, the question "I would remind myself continuously to be patient to solve problems" (Q11, t=-4.267***, p=.000) and

"When facing problems, I would deal with it calmly" (Q13, t=-3.802***, p=.001) had reached significant differences. In the GILT course, participants' patients and calmness could be trained.

5.3 Interpersonal Relationships

The t-test results regarding to interpersonal relationships are shown in Table 4. The results showed that interpersonal relationships of the participants had significant difference after the GILT course (t=-3.122**, *p*=0.004), that the participants can learn the positive interpersonal interactions. After the GILT course, they were more willing to listen, accept, concern for other members, and play their roles in the groups. The positive and negative factors of interpersonal relationships were analyzed below.

Table 4
T-TEST RESULTS OF INTERPERSONAL RELATIONSHIPS

TOPIC		N	Mean	SD	t	p
Interpersonal relationship	Pre-test	30	4.90	.53	-.3122**	.004
	Post-test	30	5.19	.40		

*p<0.05, **p<0.01

In positive factors of interpersonal relationships, the question "When members had disagreements, I could discuss with them calmly" (Q7, t=-4.014***, p=.000), "I dealt with problems in my group role (Q11, t=-.2562*, p=.070), and "I was always considerate to my group members and gave assistance proactively" (Q15, t=-2.567*, p=.016) had reached significant differences. The results showed that participants' thinking was depended on their group members; they discussed with their members without negative emotions and help each other actively in the GILT course. The question "I could stood in members' shoes" (Q2, t=-.571, p=.573, Pre-m=5.10, Post-m=5.17), "When talking with members, I would pay attention to whether members were interested in my opinions" (Q5, t=.205, p=.839, Pre-m=5.17, Post-m=5.13), and "I would try to explain my methods or concepts, and hoped members can accept my opinions" (Q6, t=-1.874, p=.071, Pre-m=4.80, Post-m=5.10) had not reached significant differences with ceiling effects. Participants thought they were important matters regarding to standing in members' shoes, being interested in others' discussions, and expressing their own thoughts enthusiastically.

In negative factors of interpersonal relationships, the question "When members' views were not the same, I could respect the final decision of the group" (Q1, t=-2.626*, p=.014), "I could accept different characteristics or personality of other members including race, religion, or even disorders" (Q3, t=-2.504*,

p=.018), "I could listen to members' discussions attentively" (Q4, t=-.041*, p=.050), "I could agree with different ideas" (Q8, t=-3.261**, p=.003), and "I could deal with unfair treatments and results well" (Q9, t=-2.276*, p=.030) had reached significant differences. After the GILT course, participants were willing to accept, respect, and empathize with their members. The question "I did not blame my members for failing the mission" had not reached significant difference, but the mean of post-test was higher than pre-test (Q10, t=-1.881, p=.070, Pre-m=4.30, Post-m=4.80). Some participants would still blame group members for their poor performances. It showed that there were insufficient positive encouragements for group developments. However, it was better than before. The researchers inferred that game mechanism might have enhanced their positive attitude, encouragements, and interactions.

The question "I always protected my group carefully" (Q13, t=-1.608, p=.119, Pre-m=4.37, Post-m=4.67) and "I would worry about whether members favored my performance" (Q14, t=1.361, p=.184, Pre-m=5.17, Post-m=4.97) had not reached significant differences. The results of the two questions showed that groups could not create sufficient sense of security in GILT course.

5.4 Game Evaluations

The t-test results regarding to the game satisfactions are shown in Table 5. The factors of the guidance interface (Q1, m=5.23), context setting (Q2, m=5.27), game interaction (Q3, m=5.37), entertainment (Q4, m=5.40), adaptability (Q5, m=5.17), interesting (Q6, m=5.30), challenge (Q7, m=5.23), and reflection after game (Q8, m=5.40) were all highly satisfied. It showed that the six games in the GILT course could present great learning contents, and the participants had enjoyed the games.

Table 5
EVALUATION RESULTS TO THE GAME SATISFACTIONS

Item	N	Mean	SD
All	30	5.30	.087
Q1	30	5.23	.729
Q2	30	5.27	.691
Q3	30	5.37	.718
Q4	30	5.40	.621
Q5	30	5.17	.791
Q6	30	5.30	.702
Q7	30	5.23	.626
Q8	30	5.40	.621

Results and Conclusion

This study tried to design a GILT course which integrated six digital games in Tuckman's team development model. Four main elements, game (G), interaction (I), learning (L), and team-building (T), are included in this course. The six games were based on traditional adventure education activities and developed by Unity3D. Thirty college participants were invited to join the GILT course. Finally, their learning effectiveness of the themes of GILT course, problem-solving abilities, interpersonal relationships, and game satisfactions were investigated with the questionnaire.

There are two research questions in this study. Question 1: Do teenagers learn adventure education themes, problem-solving skills, and positive interpersonal interactions throughout the GILT course? With positive interpersonal interactions, participants could learn adventure education themes and problem-solving skills well (Kiili, 2005; Neill & Dias, 2001). From the GILT course, participants realized that how to discuss with members calmly, deal with problems in their group roles, give assistance actively, respect the final decision of groups, accept different characteristics or personality of members, listen to members' discussions attentively, agree with different ideas, and deal with unfair treatments and results well. Moreover, through great interactions, participants' leadership, communication, support, trust, thinking outside the box, and handle frustration in adventure education themes could be trained within the GILT course. Finally, problem-solving skills regarding to identifying the problems, comparing for the possible success, implementing solutions step by step and thoroughly, rethinking, being patient to solve problems, dealing with problems calmly, and believing their own abilities were enhanced after the GILT course (Bansal, 2014; Lamm *et al.*, 2012).

Question 2: What are teenagers' attitudes toward the digital games in the GILT course? Participants felt satisfied about the six games regarding to guidance interface, context setting, game interaction, entertainment, adaptability, interesting, challenge, and reflection after game in the GILT course. The six games in the GILT course provided worthy learning contents and wonderful gaming experiences (Hsu & Shih, 2013).

The research has concluded to a few thoughts. First, for this study, the results proved that the activities of adventure education can be presented by digital games. In the GILT course developed in this study, participants can learn the adventure education themes and improve their problem-solving skills with positive interpersonal interactions (Hsieh, Wang, & Chuang, 2008; Shih *et al.*, 2010). However, it was still insufficient sense of security for members in the groups and some participants still blame their members for unachieved

missions. Second, for further research, the processes of interactions or problem-solving could be observed and investigated using qualitative methods and tools. Through interviews and observations, or even activity logs, the changes regarding to the process of interactions or problem-solving strategies could be analyzed. Finally, for future application, the GILT course can be implemented for employee training or counseling. It can be an effective tool for the extension of adventure education activities. It is not only worthwhile to explore in academia, but applied in other fields for team development or communication purposes.

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