

Analysing Group Dynamics of a Digital Game-based Adventure Education Course

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ABSTRACT

This study reported the group development training results using a digital game-based adventure education course. In the research, six traditional adventure education activities were developed into six digital games that are assembled and practiced in the face-to-face course. The course was designed based on Tuckman's team development model in which students are trained to have positive human interactions and work as a team. With Hill Interaction Matrix (HIM) and focus group, the processes of students' oral interactions in the course were documented and analysed to see each groups' group dynamics and group development conditions. The results showed that groups of all kinds can be developed into effective groups and had positive human interactions after the course.

Keywords

Adventure education, Digital game-based learning, Team development, Group dynamic, Hill Interactive Matrix

Introduction

Group dynamic is the power while group members are interacting. It can keep the group development and team-building process running, and influence behaviours of each group member and function of groups (Cartwright, 1951). Training for team-building has many types of methods. Adventure education has been an effective way for team-building. Participants are normally divided into groups to work with others, familiar or not, to become cooperative partners. Reflections are conducted after every activity led by the facilitators. Through the reflections, participants retrospect the process to train their skills of problem-solving or team work, and learn the lessons of each activity that they can further use in daily lives (Cooley, Burns, & Cumming, 2015). Nevertheless, some traditional activities were difficult to implement due to rules which are hard for the facilitators to manage, complicated activity equipment to prepare, and occasional bad weathers. However, few studies of any kind have examined the methods to solve the problems. It is also rare to find adventure education to be conducted in the any degrees of digital forms.

Therefore, this research hopes to provide a new effective adventure education course with the implementation of digital games that are easy to conduct, and can increase group interactions. Since teenagers in this digital era are generally interested in digital games, it might be a great opportunity to introduce digital technology into the activities. The digital games would make them immerse in the gaming situation, enhance learning motivation, increase learning effectiveness, and encourage them to express thoughts and emotions (Batson & Feinberg, 2006; Przybylski, Ryan, & Rigby, 2009; Schell, 2014).

Therefore, this paper aims to integrate digital games into the adventure education course to design a digital game-based adventure education course. Six traditional activities were chosen to be developed into digital games. The digital games in the course were built by Unity3D. With the advantages of cross-platform and high simulations, the six traditional activities were developed into two network computer games, two tablet games and two motion-sensing games. Those six games were used in the five stages according to Tuckman's team development model including forming, storming, norming, performing, and adjusting stages. In the course, students can play digital games, interact with their members, learn positive human interactions, and go through the team-building process in every stage. After the course, groups are expected to become effective groups. Hill interaction matrix and focus group interviews were used to investigate the effectiveness of the course. Thus, in this paper, the effects of digital game-based adventure education course on learning and human interactions would be examined. Specific research questions to be addressed are as follows: How were the group dynamics and the group development processes of each group in the digital game-based adventure education course? How did group dynamics in the reflection sessions influence group developments?

Literature review

Adventure education

Adventure education is a series of adventurous and challenging activities that allows students to participate and experience group works. After each activity, the facilitator would guide students through the reflection process, allow them to internalize the theme, and further apply them into real life practices (D'Amato & Krasny, 2011; Ewert, Sibthorp, & Sibthorp, 2014; Lund, & Tannehill, 2010). In adventure education courses, teachers act as facilitators to allow students to explore and experience course content, and immerse in learning by doing exercises (Howden, 2012). In such a way, learning has become more interesting and interactive, and learning concepts would be an activity that is less static, which can enhance learning effectiveness (Sutherland & Stuhr, 2014).

So far, adventure education incorporates outdoor activities or portable adventure activities that involve physical activities (Battey & Ebbeck, 2013; D'Amato, & Krasny, 2011). The activities are mostly conducted in groups to train group members for group coherence, leadership, communication skills, and efficiency. The activities of adventure education can be divided into three stages (Henton, 1996; Lin, Shih, & Hsu, 2013): (1) Brief: Before activities begin, facilitators have to talk to students about activity rules, goals, situations, and restriction. It is to call for students' attention to rules and goals; (2) Activity (Game): Students start to experience activities. Facilitators play the role of assistants who help students finish the courses. They are not lecturers in class; (3) Debrief (Reflection): Facilitators guide the students to understand the meanings of the activities through reflections. Nevertheless, the group development process and member relationships in the adventure education courses are strengthened but hardly observed. Tuckman (1977) has given small group development a clear definition through five stages, namely forming, storming, norming, performing, and adjusting, so that groups can become effective groups (Tuckman & Jensen, 1977). Until now, Tuckman's theory is widely used in various fields for team-building (Bonebright, 2010; Garfield & Dennis, 2012; Haines, 2014), especially in the business organizations and industries. It provides a framework for the observation and understanding of the process of team-building.

Sometimes, facilitators encounter difficulties in adapting to weather, environment, and role managements when conducting traditional activities. Thus, this research chooses adventure education activities that have high requirements for physical environment setups, and attempts to make those activities more feasible in common practices.

Digital game-based adventure education course

The only one study regarding adventure education using digital game was Hsu and Shih (2013) in which they found that participants can learn that abilities of problem-solving and positive cooperation through digital game as well as in the physical form. It proved that adventure education activities can be effectively practiced in the form of digital games.

Digital game-based learning (DGBL) has earned its fame in the recent years. Its original purpose is to use digital games to increase learners' learning motivation, and further to improve their learning abilities and effectiveness. Many research have obtained positive evaluation results in various fields and subjects (Hong, Cheng, Hwang, Lee, & Chang, 2009; Hsiao, Chang, Lin, & Hu, 2014; Suh, Kim, & Kim, 2010).

Adventure education, as closely related to counselling, is normally performed through face-to-face mode which imposes tacit pressure to the participants. To relieve the inter-personal tensions and bridge the communication between parties, participants need to have strong human interaction skills, such as listening and empathy, to lower down each other's mental defence. Game-based counselling (GBC) was first appeared in Hsu and Shih's (2012) study suggesting using digital games in the counselling process can enhance counselling effectiveness. Further down the road, when digital games alone can generate positive and similar effects as traditional counselling sessions, they can be called as Digital Counselling Games (DCG).

This study, slightly different from GBC and DCG, adds and emphasizes on the reflection session conducted by the facilitator after each game, which guides the participants to discuss through a series of targeted issues. The participants retrospect their gaming process, think about the implications of the games, and internalize the group development themes, such as interaction, communication, and cooperation; and work through the process to become effective groups with their group members. In order to understand the interaction process, Hill

Interaction Matrix is used to observe the oral interactions in the reflection session to evaluate the effectiveness of group development of the course.

Hill Interaction Matrix

Hill Interaction Matrix (HIM) is an oral interaction analysis system developed by Hill (1971) which is appropriate for investigating the interaction and change of group therapy. The analysis is done through multi-dimensional systematic categorization. Oral interactions include two major factors: Content and Work factors (Barlow, 2013; Berg, Landreth, & Fall, 2013). Content factors include Topic (I), Group (II), Personal (III), Relationship (IV) dimensions. Topic (I) refers to all general group development issues. Group (II) includes issues such as activity execution, leadership, and group cooperation; that generally come from individual feedbacks and their doubts to groups. Personal (III) includes issues concerning specific member, such as his personality and behaviours, etc. Relationship (IV) refers to issues concerning members' interactions and inter-relationships with the group members.

Work factors define types of oral interactions, which include Responsive (A), Conventional (B), Assertive (C), Speculative (D), and Confrontative (E). Responsive (A) dialogue refers to communications that are intrigued by the facilitators; members only respond with short answers without having basic social communication skills. It is often carried out by mental disabilities. Conventional (B) dialogue refers to greetings, chats, entertaining gossips without having much impact to group development. Assertive (C) dialogue refers to messages about self, mostly on defensive, divergent, replenish, and even assault words. Speculative (D) dialogue refers to discussions that are rational and supportive for members' thinking, observation, and comprehension. Confrontative (E) communication refers to the interactions that the group leader or a member tends to force the important person to face the avoided problems, which might lead to risks and intensity.

HIM result presentation uses horizontal axis to show the content factors, and vertical axis to show work factors, which forms a 4x5 matrix, with total of 20 categories (Table 1). From the analysis of oral interactions using the matrix, the facilitators can observe whether the participants' discussion dialogues have therapeutic functions.

Table 1. Hill interaction matrix

Work\Content	Topic(I)	Group(II)	Personal(III)	Relationship(IV)
Responsive (A)	I A	II A	III A	IV A
Conventional (B)	I B	II B	III B	IV B
Assertive (C)	I C	II C	III C	IV C
Speculative (D)	I D	II D	III D	IV D
Confrontative (E)	I E	II E	III E	IV E

HIM analysis method was used in many studies in counselling and medical fields to explore more in-depth psychological investigations (Kivlighan, 2014; Latour & Cappeliez, 1994; Pan, Deng, Fan, & Yuan, 2012). Consequently, this research used HIM to analyse the group interaction process of the adventure education course to investigate the group development conditions.

Course and game design

Tuckman used his group development model to explain the process of groups while becoming effective ones, which include five stages namely, forming, storming, norming, performing, and adjusting (Tuckman & Jensen, 1977). The stages are sequential, and every stage is essential for team building. The failure of one stage would cause difficulties for the groups to move onto the following stages (Johnson, Suriya, Yoon, Berrett, & La Fleur, 2002). In order to ensure that the adventure education course designed in this research would reach the goal of successful team-building, six adventure education activities were chosen from the book, One Hundred and Fifty Suggested Experiential Education Activities (Hsieh, Wang, & Chuang, 2008), and transformed them into digital games. They were Polar Bear and Hole, Cooperative Puzzle, Chessboard Maze, Moon Ball, Group Balance, and Calculator. The six activities are those that are difficult to carry out in the physical environment due to some specific requirements, or uncontrollable factors such as weather or physical space. As a result, the activities were made into digital adventure education games based on their original goals, were designed with related counselling theories and were presented in suitable digital forms. The six digital games were verified by two adventure education experts and were in accordance with their original activities. They were unlike commercial

games that were designed for general themes, they had specific training goals. After each game, one reflection session was performed to allow the participants to understand the implied meanings of the games.

Thirty students were divided into groups of five. Every two groups were invited to participate the course on the same day. The whole course was repeated three times/days to allow all six groups to complete the course. The instructional design is done as follows.

Forming stage

Members are unfamiliar with each other in the beginning stage, and they try to search for group goals together. Members are searching for their roles in the group at this time. Using ice-breaking activities would give members chances to communicate, share, present their opinions, and get familiar with group dynamics, common values, and individual thoughts. It allows the members to build relationships between them. The game used in this stage is Polar Bear and Hole. With a lead story, participants try to solve the riddle with reasoning skills and speculations. The main theme of the game, Polar Bear and Hole, is to listen. Participants learn to listen to embedded meanings in the communications. "Listen" is the first ability the participants need to strengthen in the interpersonal interactions.

Storming stage

Members start to find their own goals, have their own thoughts, and manage things from their own perspectives at this stage. Individuals start to make influences to the group. In this stage, activities that require little oral communications were chosen so that all members observe each other's needs and create individual values during the game. At this point, members have internal dialogues, face group challenges, make improvements, and move toward effective group. The game used in this stage is Cooperative Puzzle. Every member gets three puzzle pieces randomly out of 15 pieces. Each has to complete a square puzzle of his own. Five members have to complete five square puzzles at the same time in order to finish the game. In the process, members have to exchange puzzle pieces without any oral communication. Also, puzzle pieces can only be given instead of asked. The goal of the game is to make the members observe others' needs to reach the group goal, think about what they can do for the group, and identify their roles in the group. They have to learn that individual accomplishment is not group accomplishment. Every member needs to work toward group welfare to reach final success. Another game used in this stage is Chessboard Maze. Members have to take turns to pass a 4 by 5 chessboard maze which is full of landmines. There is only one safe route. Once stepped the landmine, the player has to return to the start point by going back on the same route. The members take turns to try out the maze until finding the correct route. What other members have to do at the same time is to figure out and memorize the correct route, and then give directions to the player in the maze. The purpose of the game is to build trust between group members, define group strategies, and learn the value of trial-and-errors. Group members have to pass their experience on to other members, and work with bravery when it seems to be dead-end.

Norming stage

In this stage, groups start to have group goals centered by the leader and rules. Members learn to accept others' ideas, willing to make adjustments to changes of conditions, to redefine their positions in the group, and play their own roles faithfully in the groups. They communicate, trust each other, and use strategies to work effectively toward group goals. The game used in this stage is Moon Ball. Members have to take turns to pat the ball for the longest time they can accomplish. The purpose of the game is to train members to collaborate with each other to achieve the goals. Problem-solving strategies and team work spirits are the core abilities for this game. They are generated from the actions, but not from the insights.

Performing stage

In this stage, the group can see the results of their efforts. Through all the frustrations they encountered in the earlier stages, the groups should have known the strategies to complete the task and create the peak experience. Members now search for dynamic changes and further advancement. They are willing to support colleagues, and can acknowledge the common goals with individual prospects and group ideals. The game used in this stage is Group Balance. Three members play the game in each session; one on the virtual balance board keeping balance

and the other two members stands at the two sides controlling the balance and heights of the board. They have to push the board upward with equal strength until the board reaches the top while keeping the person in the middle stand steadily on the board. To complete the mission, members should trust each other, and find collaboration strategies. The balance of the board signified the agreements between members; however, the disagreements are the group dynamic that move the group forward. Positive arguments would stimulate motivations, but negative arguments would hinder group's creativity.

Adjusting stage

Group development progress would come to the end as members share their experiences and create common memories. After this point, groups might face member changes; when new members join the group, the group development would enter another cycle. The game used in this stage is Calculator. In this game, there are 30 ladybugs in the virtual garden with numbers 1 to 30 on their backs. Group members have to cooperatively catch the ladybugs in consecutive order in their highest speed. This exciting game is actually testing the members to re-identify their roles in the group, and work effectively as a group.

Research methods

This study is about group development in digital game-based adventure education course so qualitative research design was used to conduct in-depth analysis on group dynamics and group development (Figure 1). Thirty participants, aged between 19 and 25, from two different colleges volunteered to participate in the study. They were randomly divided into six groups so the group members were not familiar with each other in the beginning.

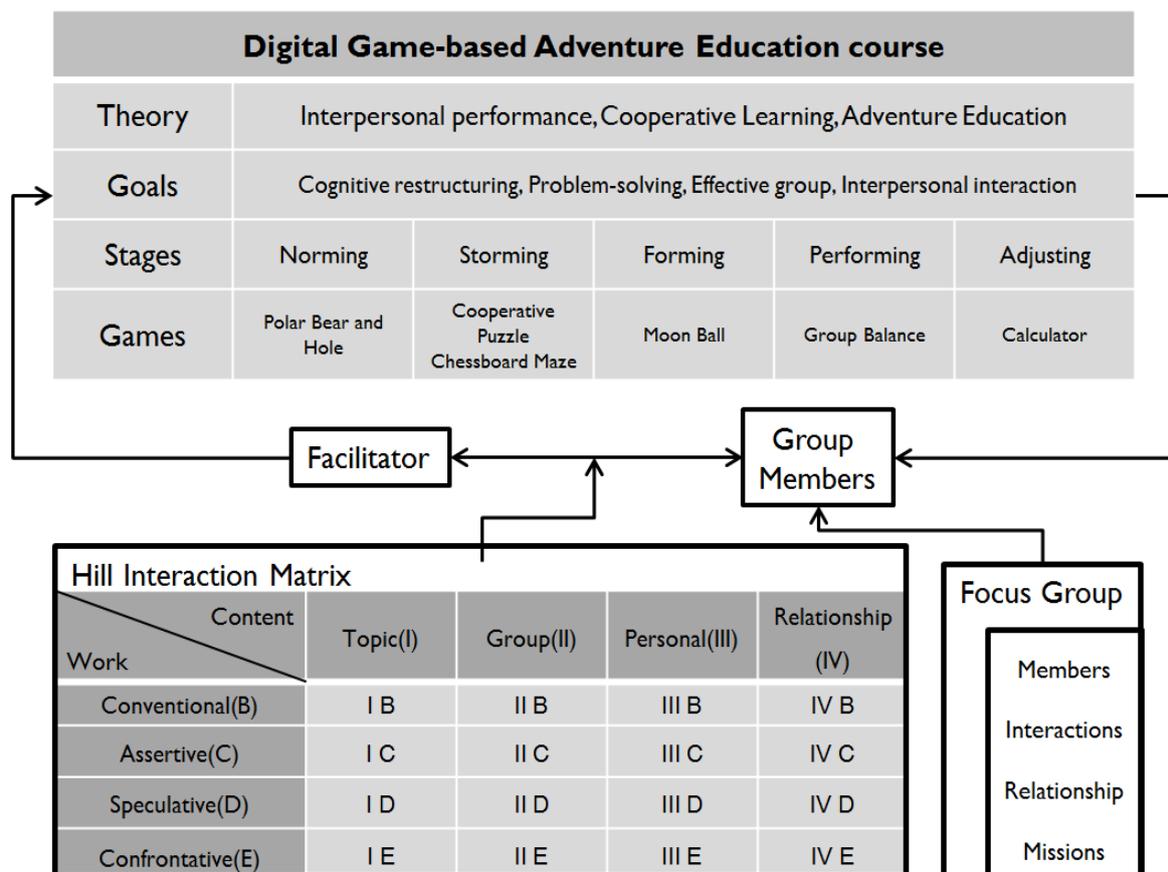


Figure 1. Research structure

The whole course was conducted in repetition for three days, six hours each. The same facilitator led 10 students of two groups through the course in each day. In six hours, each game was run for one hour including 40 minutes game time and 20 minutes group reflection session. The reflection sessions were conducted after each of the six games for the members to retrospect the gaming process and think about the themes of the games. In the course,

participatory observation was used and the facilitator also acted as an observer to record the dynamics of each group. The oral interactions of all reflection sessions were recorded in both audio and video forms. Effective group means that members can solve problems or missions effectively and they have great positive interactions during problem-solving. Also, they can give positive feedbacks for their own group in the reflection session after activities. In the course, the difficulty of game goals and problem-solving increases in each stage. Members need to have better performance to solve the game missions in time. It was called effective group once they could be finished game goals of six games in time and have effective feedbacks in reflection after game.

In order to investigate how group interactions influence team development, HIM was implemented for analysis (Hill, 1997). The dialogues in all the reflection sessions were recorded and analyzed sentence by sentence. The data were encoded into HIM quadrants by the primary researcher along with the facilitator. Since Responsive (A) is only used for mental disability patients, this research discarded the aspect, and came up with total of 16 oral categories. Two skilled coders with adventure education background were invited. Analysis revealed the reliability of the Multi-rater Fleiss Kappa coefficient k to be 0.85. It achieved a high degree of consistency (Landis & Koch, 1977).

At the end of the course, focus group interviews were conducted for 20 minutes to understand the participants' perceptions to the group interactions throughout the course, and receive overall feedbacks to the reflection sessions. The interview themes were mainly about their impressions to their group members, the interactions during the games, the relationships between members, the strategies used to complete the missions, and the difficulties they encountered during the process. The discussions of focus group interviews were also transcribed for analysis.

Research results

Group dynamic analysis

In this section, group dynamics of each of the six groups were analyzed in terms of the interaction frequencies in the four HIM quadrants. The HIM analysis results of Group 1 to Group 6 were shown in Figure 2 to Figure 7 respectively.

The results show that the interactions of all the groups in all stages laid mostly in Quadrant II which is about group issues. It is mainly because the facilitator focused more on the discussions about the gaming processes instead of about their personal feelings towards other members and games so most of the conversation issues were concerning group interactions (Quadrant II).

Looking into each individual group, we can see various group dynamics. In Group 1, two of the members were active speakers who responded to the facilitators more willingly which resulted to a more dynamic discussion of the whole group. It was comparatively easier for the facilitator to bring the group discussion from issues in Quadrant II to Quadrant IV. Since they were more willing to tackle the issues concerning group relationships (Quadrant IV), they were more effective in maintaining positive group interactions which led to better game performances.

Group 3 had slightly different curve from other groups on the storming stage in which the games Cooperative Puzzle and Chessboard Maze were conducted. The group members tend to be more introverted, that they were shy in communicating with each other. Their interaction frequency rose to the peak in Chessboard Maze when the facilitator required the members to talk. As a result, this group entered the storming stage since then.

Group 5 and 6 had less interaction in the storming stage in all four quadrants because they complete the missions in Chessboard Maze too quickly. From the interviews they said they happened to guess the answers right so they finished the game fast. From the background analysis it is found that the members in these two groups were with more digital technology experiences that they seem to handle technology more easily. Therefore, the members of the two groups did not experience the interaction conflicts and frustrations that normally exist in the storming stage. Thus, the facilitator was not able to guide the group through difficulties that were expected to happen in the group development. As a naturally consequence, the two groups spent more time on the following games to reach the same group development goals as others since they did not nurture sufficient group spirits in the storming stage.

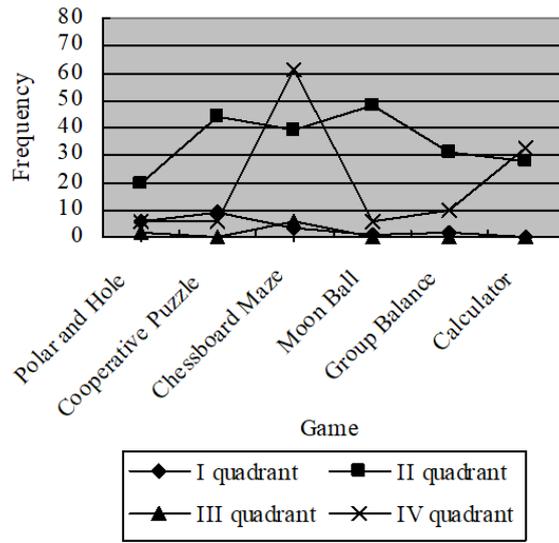


Figure 2. Group dynamics of Group 1

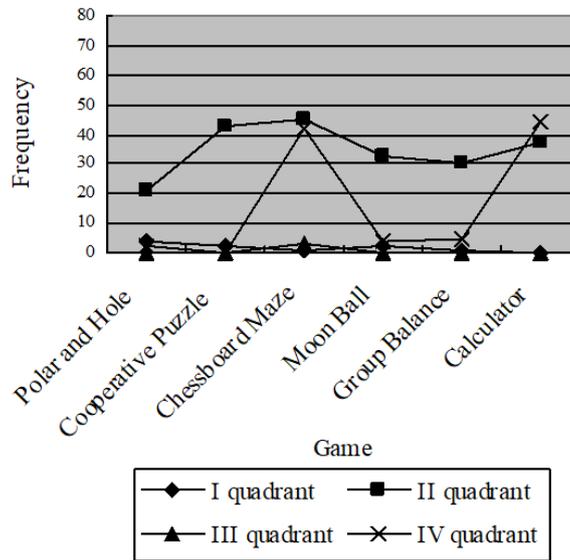


Figure 3. Group dynamics of Group 2

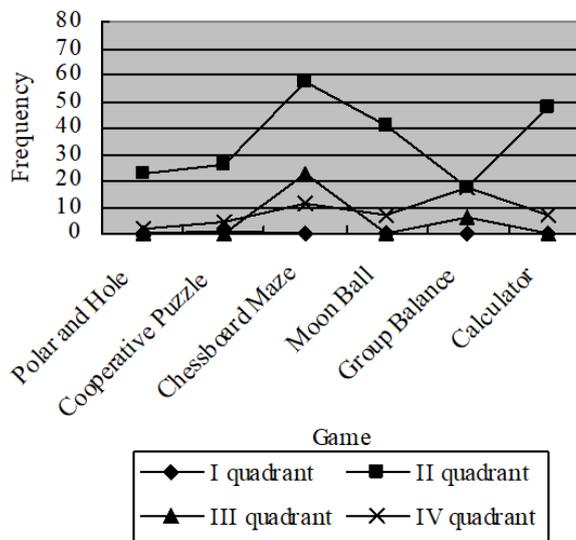


Figure 4. Group dynamics of Group 3

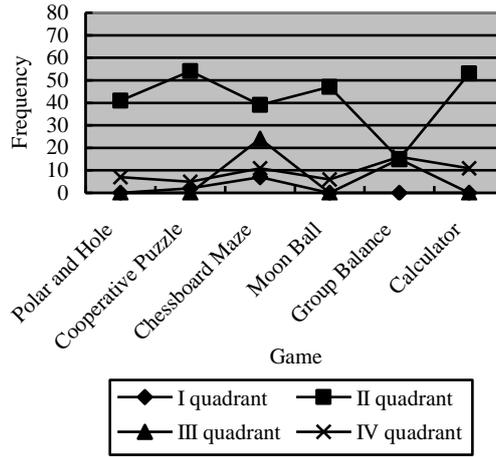


Figure 5. Group dynamics of Group 4

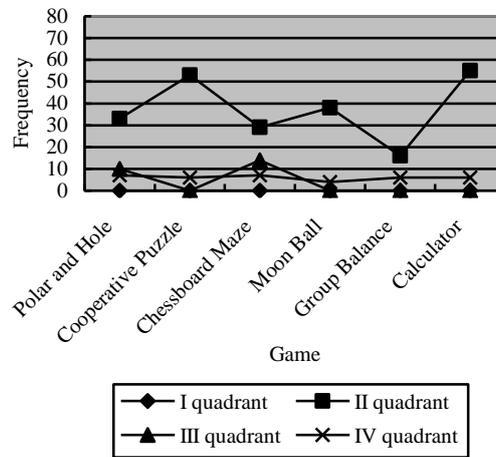


Figure 6. Group dynamics of Group 5

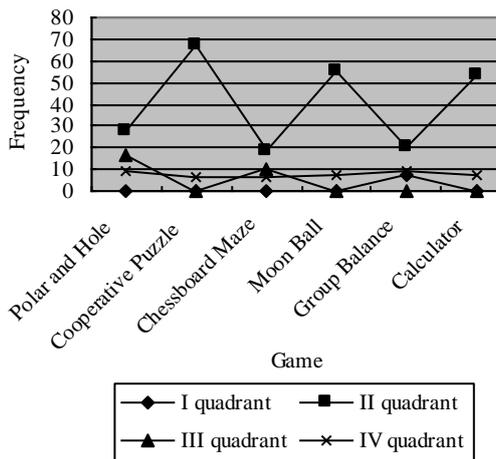


Figure 7. Group dynamics of Group 6

Table 2 shows the sum of oral interaction frequencies of all groups in all stages in HIM classification. Related research indicated that facilitator’s guided talks and directions could greatly influence the interactions between members (Hill, 1977). In this study, members had more conversation focused on Conventional (B) (78%) and Speculative (D) (20.34%) which showed that the facilitator and the members reflected more issues about group activities. In this research, communication content were mostly focused on Group (II), Personal (III) and

Relationship (IV), among which mostly lied on IIB (56.39%), IID (12.93%), IIIB (3.8%), IIID (2.97%), IVB (17.19%), and IID (3.43%).

Crossing with the observation records, it is found that the facilitator tended to guide the reflection sessions in the style of Conventional (B) followed by Speculative (D) to treat things rationally, stimulate other members to think, conduct rational discussions to increase their comprehension abilities to problems. In terms of the topic transactions, the facilitator used issues about Group (II) followed by Relationship (IV) to discuss the member interactions in the games. After that, issues switched to Personal (III) to investigate members' characteristics and behavioral models. Meanwhile, the reflection issues least focused were Assertive (C) (1.35%) and Confrontative (E) (0.31%). It showed that the facilitator and members made little discontentment statements. All six groups were in peaceful, respective, safe and positive environment.

Table 2. Oral interaction frequencies of all stages in HIM

Work/Content	Topic(I)	Group(II)	Personal(III)	Relationship(IV)
Conventional (B) (78%)	12(0.62%)	1086(56.39%)	73(3.8%)	331(17.19%)
Assertive (C) (1.35%)	16(0.83%)	5(0.26%)	0(0%)	5(0.26%)
Speculative (D) (20.34%)	20(1%)	249(12.93%)	57(2.97%)	66(3.44%)
Confrontative (E) (0.31)	0(0%)	5(0.26%)	0(0%)	1(0.05%)

Based on those results, it is affirmative that most of the group interactions were positive. Thus, in this section, the process of group development would be analyzed.

In an overview, all six groups finished all the games in 40 minutes. Comparing the total interaction frequencies of all six groups in the reflection session of each stage, the research has reached some findings. Group 1 to 4 had great peak at the storming stage, especially at the game Chessboard Maze. The participants all pointed out in the focus group about the importance of this game to group development. *"I never talk to strangers before, but now I would try to communicate with others. When the game started, we distributed works among members and try our best to achieve the goals (St-01-001, St-01-002)."* Throughout the course, members work from being strangers to being positive and effective groups.

On the contrary, Group 5 and 6 had interaction frequency drop in the storming stage and peak in the adjusting stage. They finished the game Chessboard Maze to quickly that they did not have chance to work on the group relationships. There is little infusion between members and they missed the process of dealing with communicative frustrations. Until they reached the stage of the game Calculator, they started to have massive amount of communication since the groups need to make up the missing process of necessary group development. *"In the beginning, we feel unfamiliar with each other. But to the last game, we get to know each member's characteristics, and know how to interact with each other (St-03-002, St-03-005)."*

Overall speaking, all six groups became effective groups after the course regardless of their interaction types through the group development stages. The only differences between the two kinds of groups are the game time they spent in the last stage for group development. Group 5 and 6 spent half an hour more in the last game to reach the same level of group development (Table 3). The storming stage of group development is considered as an opportunity to increase positive interaction through conflicts (Gilley, Morris, Waite, Coates, & Veliquette, 2010; Pelegrini Morita & Marie Burns, 2014; Tuckman & Jensen, 1977). Therefore, if groups do not have sufficient interactions in the storming stage, the speed of group developments would be hindered.

Table 3. Calculator game completion time in the adjusting phase

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
14 min	23 min	15 min	27 min	40 min	52 min

Participants generally agreed that the reflection sessions after each of the games were helpful for group development, and had positive influence to the following games. *"I feel every reflection after the game is important and helpful to group development (St-01-036)."* Through the guided reflections, group interactions were improved, and working strategies were generated. For example, members thought that *"I found group communication started from the game Moon Balls. We started to divide works between us (St-02-042)."* From positive interactions and discussions, group members have more thoughts toward the group goals and better understandings to each other. For example, members thought that *"Since everyone has different perspectives, the communication made us to think more and learn from the previous experiences (St-03-049, St-03-050)."*

Correlation between group dynamic to group development

It is found that the treatment effect of the reflection session in the storming stage has great impact to group development after the storming stage (Gilley et al., 2010; Pelegrini Morita & Marie Burns, 2014; Tuckman & Jensen, 1977). The game in adjusting stage is presented to examine whether the group development is effective. One the group development is not working well, the finishing time in adjusting stage would be affected. Comparing the finishing time of Calculator in adjusting stage and the reflection content in storming stage of every group, the influence of group dynamic to the effectiveness of group development can be analyzed. To investigate the correlation between the two (Calculator's the finishing time and the reflection content in storming stage), Pearson product-moment correlation coefficient was used (Table 4). Since the storming stage included two games, Cooperative Puzzle and Chessboard Maze, their effects, in terms of various interaction frequencies, were checked both separately and jointly with the finishing time of the adjusting stage.

The research shows high positive correlation between the finishing time of Calculator in the adjusting stage with Cooperative Puzzle Quadrant II ($r = .856^*$), sum of Quadrant II & IV ($r = .847^*$), and sum of Quadrant II & III & IV ($r = .847^*$). The main reason is that the facilitator did not control the reflection time in Cooperative Puzzle equally among stages and among groups. Moreover, Group 1 and Group 2 had shorter reflection time (approximately 6 minutes), and Group 5 and Group 6 had rather longer reflection time (approximately 13 minutes). The inconsistency of the reflection time had influenced the accuracy of the measure. Therefore, the following discussion will exclude the discussion of Cooperative Puzzle.

Table 4. Correlation coefficient of Calculator's the finishing time and the reflection content in storming stage

	1	2	3	4	5	6	7	8	9	10
1. Calculator's the finishing time	1									
2. Quadrant I	-.287	1								
3. Quadrant II	-.889*	.101	1							
4. Quadrant III	-.083	.349	.301	1						
5. Quadrant IV	-.619	.153	.270	-.673	1					
6. Quadrant II & III	-.699	.244	.887*	.707	-.125	1				
7. Quadrant II & IV	-.884*	.165	.663	-.387	.900*	.305	1			
8. Quadrant III & IV	-.817*	.359	.483	-.369	.936**	.180	.947**	1		
9. Quadrant II & III & IV	-.980**	.289	.911	-.099	.757	.554	.956*	.904*	1	
10. All Quadrant	-.976**	.378	.794	-.062	.747	.559	.941**	.910*	.996**	1

Note. * $p < .05$; ** $p < .01$.

The research shows high negative correlation between the finishing times of Calculator in the adjusting stage with Chessboard Maze Quadrant II ($r = -.889^*$), Quadrant II & IV ($r = -.884^*$), and Quadrant III & IV ($r = -.817^*$). In this stage, the facilitator had effectively guided the discussion from Quadrant II to Quadrant IV, and then to Quadrant III; thus, the discussion has reached group development goals. Further, the highest correlation happened in Quadrant II & III & IV ($r = .980^{**}$) which shows the game had successfully strengthen group coordination that led to effective group reflections, and resulted in less time to complete the game in the adjusting stage. Due to the frequencies of Quadrant I is close to zero, the results of the Chessboard Maze All Quadrants ($r = -.976^{**}$) was ruled out.

The correlation of the total sum of interaction frequency in the storming stage did not reach statistical significance due to the reason that the two games have reversed results that balanced out the outcomes. However, in the result of Chessboard Maze, team members can spend less time to complete the game mission in the adjusting stage if their oral interactions focus on Quadrant II, Quadrant II to III, Quadrant III to IV and Quadrant II to IV and the reflection is conducted in same time by the facilitator in the storming stage.

Results and conclusion

Digital games have the advantages of working out of the limitation of environment and uncontrollable factors such as weather for adventure education courses. Meanwhile, digital games are also a natural attraction to teenagers. Therefore, this research chose six adventure education activities that had counseling theoretical underpinnings and transformed them into digital games. The digital games were cohered into an adventure education course based on Tuckman's team development model which purpose is to increase group dynamics to enhance group development. Since the main purpose of this research is to understand the effects of digital game-

based adventure education course to groups of various styles, experimental design was not appropriate. Instead, qualitative analysis of the group interactions was conducted with HIM without considering individual factors. All courses were guided by the same facilitator that reflection facilitation style was controlled in the minimal variation.

For research tool – HIM, through HIM and focus group interviews, the reflection sessions after each of the games in the course had significant positive influence to group development, and could improve group performances in the following games. The guiding style of the facilitator affected group development with positive interactions in each of the stages, especially when members faced conflicts in the storming stage (Gilley et al., 2010; Pelegrini Morita & Marie Burns, 2014; Tuckman & Jensen, 1977). From results of HIM, the reflection style focused on the issues of Group (II), Personal (III), and Relationship (IV) was useful for group dynamic and group development (Hill, 1977). For group dynamic, all the six groups finished the first four stages in time. After great reflections, they could solve game missions with better communications and cooperation in next game (Williams & Sternberg, 1988). However, Group 5 and 6 spent half an hour more in the last game to reach the same level of group development. The result was caused by their insufficient interactions in Chessboard Maze at the storming stage. Group 1 to 4 had great peak at the storming stage reversely. All in all, six groups have become effective groups after the course (Johnson et al., 2002).

Though this paper did not investigate the comparison of digital games and traditional adventure education activities, we could refer to the study of Hsu and Shih (2012) to assume that digital games were better than traditional activities among problem-solving and team work. Hsu and Shih (2012) also agreed with the features of digital games were attractive for students. In the past, the studies of team-building focused on human resource and interaction of physics or digital context. However, the course combining adventure education and digital game-based learning in this study was aimed to investigate group dynamic and group development. We expected to provide a digital tool to be applied in adventure education. Nevertheless, this paper confirmed that Tuckman model was also useful in digital game-based learning (Gilley et al., 2010; Pelegrini Morita & Marie Burns, 2014; Tuckman & Jensen, 1977).

The research has drawn to a few conclusions. First of all, using technological tools to add onto the adventure education is feasible and can be successful if designed and guided with proper manner (Hsu & Shih, 2012). Digital learning system can provide simulated environment for the adventure education, but also offer the facilitator important process records for participant observations. In this study, there is high requirement to course assistance. In the future, with system enhancement, working personnel who were responsible for observation and documentation can be reduced. Second, the course was designed with Tuckman's team development model that the digital game-based adventure education course can appropriately advance group development to become effective groups. Third, the course designed in this research is targeted to team development and human interactions that more learning issues can be explored in the future to test its effectiveness on different variables. Fourth, the games designed in this research can allow participants' full immersion but some factors were uncontrollable such as unstable network connection and game system bugs that caused occasional game interruptions. Technological improvements can be resolved in the time being. Next, the guiding style of the facilitator would greatly influence the effectiveness of the course and the success of team development. Training to the facilitator to focus on learning issues can be conducted for the courses so that course qualities can be guaranteed. There would be more facilitators available for digital-game based adventure course if training courses can be given. Course structure, course design, and time controls regarding game and the reflection sessions, etc., are to be attended to maintain the quality of treatment. Through the results, it proved that reflection sessions were greatly helpful for group development and positive interaction. Last, the participants chosen in this research are teenagers. In the future, heterogeneity of group members can be tried; the course can also be transformed to adopt children, people with disabilities, or even elderlies. The games developed in this study are easy to manipulate that can be used in wider range of issues for a variety of participants. The potential of the digital game-based adventure education courses can be extended in the future.

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