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Comparing Collaborative and Cooperative Game Play for Academic and Gaming Achievements

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Abstract

This paper reports an empirical study that explores gender differences in both cooperative and collaborative social gaming in relation to achievements and attitudes. Another aim was to compare students' game attitudes, feelings towards group work, and achievements in cooperative versus collaborative digital game-based learning environments. One hundred sixty-four, sixth grade students from five different classrooms at an elementary school in South Korea participated voluntarily in this study. A total of two boys and two girls were randomly assigned to each group resulting in twenty groups for each of the grouping conditions. Based on interaction effects, results suggest that male students show more positive games attitudes in collaborative conditions, whereas female students show more positive game attitudes in cooperative conditions. Data also suggest that males show more positive feelings towards group work than females, irrespective of grouping conditions. Regarding academic and gaming achievements, female students showed higher academic achievement in collaborative conditions while male students scored higher on academic achievement under cooperative conditions. Findings from this study indicate that gender-balanced groups show significantly higher gaming achievement in collaboration compared to cooperation. Results are interpreted with reference to future research and classroom practices.

Keywords: collaborative learning; cooperative learning; game-based learning; gaming achievement; Minecraft

1. Introduction

The current impact of digital social games in education is evident and increasingly relevant (Jong, Shang, Lee, & Lee, 2008; Vasalou, Khaled, Holmes, & Gooch, 2017). Video games can provide answers to problems encountered in traditional classroom environments such as lower cognitive outcomes and poor attitudes towards learning (Vogel, Vogel, Cannon-Bowers, Bowers, Muse, & Wright, 2006). Students who engage with video games are often required to challenge themselves, to collaborate and interact with peers, and to think critically, which are all necessary and tangible digital-life skills to thrive in this technology-driven world (Marsh, 2014). More specifically, social and collaborative games can improve student engagement and consistently provide opportunities for children to learn and practice social skills (Fenstermacher, Olympia, & Sheridan, 2006). Social skills are related to specific positive outcomes such as peer acceptance, positive peer relationships, academic achievement, and teacher acceptance (Lane, Menzies, Barton-Arwood, Doukas, & Munton, 2005). Thus, the different communication possibilities and levels of interactions embedded within digital social gaming platforms make it possible for different types of learners to engage with learning content in a familiar and enjoyable way.

Collaboration in learning is broadly defined as a process that involves sharing knowledge, ideas, and feelings with group members (Jarvenoja & Jarvela, 2009). Collaborative learning is most effective when students appropriately use their socials skills, which allows more accurate communication with others and more constructive conflict resolutions (Johnson & Johnson, 2009). Several authors (Hammond, 2017; Johnson, Johnson, & Smith, 2014; McClellan, 2016; Oxford, 1997) provided a theoretical comparison between cooperative and collaborative learning to highlight the conceptual differences between the two grouping conditions in educational research. In their systematic review of related empirical evidence, Johnson, Johnson, and Smith (2014) claim that cooperative learning, which is a process that leads to an assembled product by splitting the workload, promotes higher achievements and positive attitudes compared to competitive and individualistic learning among university students. When compared to collaborative learning, McClellan (2016) describes cooperative learning as a more productive and a more efficient approach. To

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this date, however, the growing interest has been limited to either the theoretical characterizations of collaborative and cooperative learning or simple comparisons of cooperative/collaborative learning methods in relation to competitive and individualistic conditions.

An exception to this comes from the work of Beznosyk, Quax, Coninx, and Lamotte (2011) who provide a comparative analysis of user performance and enjoyment in a collaborative and a cooperative virtual environment. The researchers focused on examining players' differences in relation to task completion time, enjoyment, and performance and found that continuous communication and joint manipulation of objects where key to an enjoyable experience regardless of players' prior experience. Despite the fact that Beznosyk et al. (2011) provide valuable insight into players' behaviors when collectively manipulating objects in virtual environment, their effort lacks conceptual accuracy particularly when describing and applying cooperative and collaborative conditions in social gaming. For example, the division of labor was implemented in collaborative play whereas real time coordination and communication were used in cooperative play. Consequently, it is essential to investigate user behaviors, attitudes, and achievements in these two types of conditions with more accurate theoretical characterizations.

Echeverría, Améstica, Gil, Nussbaum, Barrios, & Leclerc (2012) contend that coordination and communication between peers, individual accountability, and awareness of peer's work are three conditions that a technological platform must support to create a successful collaborative learning environment. Minecraft, which is the platform used in the context of the current study, is a game that revolves around collaboration, exploration, and adventure (Zorn, Wingrave, Charbonneau, & LaViola, 2013). The open-ended nature of Minecraft provides more freedom and flexibility for the design and implementation of cooperative and collaborative learning tasks within curricular activities. When used in social environments, Minecraft provides a platform to showcase user-built structures and own creative content outside of the game (Callaghan, 2016). The community of Minecraft Makers on YouTube, for instance, is a good example of self-motivated learners who create and share contents while working collectively to reach common goals (Niemeyer & Gerber, 2015).

There are implications within Digital game-based learning (DGBL) research that gaming achievement and academic achievement are closely related. For instance, Heeter, Lee, Medler, and Magerko (2011) found that individuals who are more motivated to perform better than others in gaming contexts are also more motivated to achieve better academically. More importantly, and as Heeter et al. (2011) point out, skill mastery, progression, peer admiration, and rewards are all essential components of both gaming and education contexts. However, what is lacking in previous DGBL research that includes learner achievements and outcomes is explicit consideration of both gaming achievement and related subject achievement as two essential parts of overall student achievement.

Jarvela, Jarvenoja, and Veermans (2008) explain that successful collaborative learning depends on the quality of social interaction among participants. Therefore, exploring students' feelings toward group work is not only an important indication of the quality of group social interactions but is also helpful in the design and application of collaborative learning activities (Merrell, 2001). In addition to students' feelings towards group work, students' attitudes towards games is also an important determinant of performance and achievements in game-based learning activities (Goudas, Magotsiou, & Hatzigeorgiadis, 2009). Students' attitudes towards new technologies have long been viewed to have a critical role in the achievement of educational objectives. In the context of digital game-based learning (DGBL), students who have more positive game attitudes are more intrinsically motivated to play (Baek & Touati, 2016). Therefore, research needs to pay attention not only to students' attitudes towards group work, but also towards games used in study contexts, which can determine students' involvement in learning tasks and their interpersonal interactions within the group. As such, the present study considers both types of attitudes to get better insight into the relationships between grouping conditions and achievements in a digital social learning game.

While there is already vast literature about the theory and practice digital game-based learning, little is known about the different impacts of collaborative and cooperative learning in DGBL. The inaccurate and inappropriate use of group-learning approach terminologies in educational research has made it difficult to distinguish between them. McInnerney and Roberts (2004) contend that "this conflation of terms has resulted in implementation methods and research results being hard to asses" (p. 204). Consequently, in this paper, we take a more accurate approach to examine how gender and group learning conditions (in this case collaboration and cooperation) affect attitudes and achievements in a virtual social game. The game at the center of our study, Minecraft, successfully defines the sandbox genre and has gained wide acceptance among children recently, especially for its promising social aspect (Mavoa, Carter, & Gibbs, 2017). Additionally, like other sandbox games, the core gameplay mechanics in Minecraft is to allow

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players to create their purpose of the game and to construct new elements in the virtual environment such as reenactments of real-world buildings. To this day, despite the popularity of Minecraft in education and educational research as a social learning tool, the nature of player's assigned subtask (symmetric versus asymmetric roles) and how it affects achievements is an area that has not been considered in previous DGBL research. Gender differences in collaborative and cooperative group conditions in digital social games that allow flexibility in students' roles is also an area that is overlooked. To address this shortcoming, we take the first step towards understanding gender differences in both collaborative and cooperative grouping conditions. Another important aim was to investigate the impact of these two conditions on students' attitudes and achievements. Accordingly, we examine the following research questions:

1. What is the effect of gender and grouping conditions (i.e., collaborative versus cooperative) on students' attitudes towards the game, feelings towards group work, and academic achievement in a digital social game?
2. What is the effect of collaborative and cooperative conditions on gaming achievement in a digital social game?

Based on the aforementioned questions, the following hypotheses were generated:

1. a) There is no significant difference in students' attitudes towards games based on the students' gender when learning with a digital social game.

   b) There is no significant difference in students' attitudes towards games based on the type of grouping condition they participated in when learning with a digital social game.

   c) There is no difference in students' attitudes towards games based on the type of grouping condition the students participated in and their gender (interaction effect) when learning with a social game.

2. a) There is no significant difference in students' feelings towards group work based on participants' gender when learning with a digital social game.

   b) There is no significant difference in students' feelings towards group work of students based on the type of grouping condition the students participated in when learning with a digital social game.

   c) There is no significant difference in students' feelings towards group work based on the type of grouping condition the students participated in and their gender (interaction effect) when learning with a digital social game.

3. a) There is no significant difference in students' academic achievements based on the students' gender when learning with a digital social game.

   b) There is no significant difference in students' mean academic achievements based on the type of grouping condition the students participated in when learning with a digital social game.

   c) There is no significant difference in students' academic achievement based on the type of grouping condition the students participated in and their gender (interaction effect) when learning with a social learning game.

4. There is no significant difference between the mean gaming achievement of students in collaborative conditions and those in cooperative conditions when learning with a social learning game.

2. Literature Review

2.1 Principles of Collaborative and Cooperative Learning

In the context of teaching and learning, collaboration is a term often used to describe the concept of working together, while cooperation refers to learning situations where a division of labor takes place (Schäfer, Holz, Leonhardt, Schroeder, Brauner, & Ziefle, 2013). The concepts of collaborative learning and cooperative learning have been commonly used and discussed in learning environments as if they were interchangeable. However, evidence from the literature points out some significant conceptual differences between the two approaches to teaching and learning. When compared with collaborative learning, cooperative learning provides more structure and more explicit directions to students about how to work collectively in a group (Oxford, 1997). Johnson and Johnson (1991), who were among the first to define cooperative learning, suggest promoting individual accountability and even individual contributions,

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which is a defining feature in cooperative learning. In the context of DGBL, by allowing each player to hold a single piece of information or knowledge, each group member can provide a valuable contribution toward achieving the common goal. That is, the heterogeneity of resources is what positively impacts the quality of interactions (Fidas, Komis, & Avouris, 2005) and prevents a single person from taking control of the group (Wendel, Hertin, Göbel, & Steinmetz, 2010). When it comes to designing cooperative activities, the jigsaw learning method seems to be suitable for the affordances of augmented reality and is an integral component of several games used in educational contexts. In literature, the jigsaw cooperative learning model refers to a teaching approach that allows students to become experts in a specific subtopic that they study and research before teaching it to the rest of the group, thus building positive interdependence between group members (Berger & Hänze, 2015). In the context of DGBL, a good example of a jigsaw activity is a game called Alien Contact (Dunleavy, Dede, & Mitchell, 2009) in which students use a map on their mobile devices that display digital objects and virtual people in an augmented reality world superimposed in real space. While each team member assumes a different role (i.e., chemist, cryptologist, computer hacker, and FBI agent), successful navigation of the environment depends on sharing information between students to solve various puzzles. Although research on collaboration and cooperation in DGBL is an area that is still emerging, the early evidence tends to link the activity design to students' behaviors in collaborative multiplayer settings. For instance, Nebel, Schneider, Beege, Kolda, Mackiewicz, and Rey (2017) investigated learning and performance using the jigsaw strategy in GBL and concluded that forcing students to work together increases task performance and interactions, which in turn benefits individual learning. The application of cooperative approaches and particularly jigsaw strategies in mobile game-based learning has elicited different conclusions and interpretations. For example, Dunleavy, Dede, and Mitchell (2009) found that the size of the group can impact the contribution of each member in game-based learning activity where students have different roles. In a similar context, Lee, Parsons, Kwon, Kim, Petrova, Jeong, and Ryu (2016) conclude that self-interest should align with collective interest for the success of interactive cooperation. They also noted that asymmetry in subtasks (i.e., different roles) is a crucial component in designing future cooperative learning games.

In addition to positive interdependence and individual accountability, Kagan and Kagan (2009) identified equal participation and simultaneous interaction as critical attributes to cooperative learning. However, since students in a cooperative learning environment split the workload, solve sub-tasks individually, and later assemble these partial results to formulate the final product, simultaneous interactions and synchronous communication may be attributed less to cooperative learning environments and more to collaborative learning where students perform similar tasks (Touati & Baek, 2017).

The focus of collaborative learning is more on working with each other toward the same goal, rather than working together or interdependently (Davidson & Major, 2014). Dillenbourg (1999) identified three key criteria to describe the situation in which students interact in a collaborative way: interactivity, synchronicity, and negotiability. In a collaborative learning environment, group members participate in synchronous joint problem solving while arguing their standpoints, negotiating, and trying to convince other members about specific task details. More importantly, they perform similar actions to achieve a common goal. Negotiation in collaboration is not only essential to develop shared goals, but also to become aware of any goal discrepancies, which could result from disagreements in actions (Dillenbourg, 1999). Davidson and Major (2014) argue that the goal of collaborative learning is to make students more responsible for their learning through collective knowledge construction, thus shifting the responsibility away from the teacher. Nonetheless, teachers should still specify the student interactions in collaborative learning to help foster co-construction of argumentative and domain-specific knowledge (Weinberger, Fischer, & Stegman, 2005).

2.2. Gender-Related Differences in Game-Based Learning

The effect of gender composition of the group on behaviors and achievements in technology-based collaborative learning has increased in importance and popularity as a topic of research in recent years. However, the findings are not altogether consistent. For instance, Zhan, Fong, Mei, & Liang (2015) examined the impact of gender grouping strategies on performance in computer-supported collaborative learning and found that male students perform better in mixed-gender groups than in single-gender groups; whereas, female students performed the same in both grouping conditions. Other studies (Bennett, Hogarth, Lubben, Campbell, & Robinson, 2010; Xie, 2011) revealed no significant effect of gender group composition on achievement in collaborative learning. Another area that has received increased focus over the years is gender differences in achievement in cooperative and competitive learning conditions. For instance, it was suggested that male students exhibit more positive emotions in competitive game- play (Kivikangas, Kätsyri, Järvelä, & Ravaja, 2014) and that they cooperate more with their groups in increased competition when compared to female students (Van Vugt, De Cremer, & Janssen, 2007).

There are implications within educational research that gender does not affect students' achievements in cooperative learning environments (Achor, Musa, & Duguryil, 2014; Mbacho & Changweiywo, 2014). The study by Achor et al. (2014) in particular, investigated the effect of jigsaw strategy and student team achievement division (STAD) as two cooperative learning strategies on achievement and found no significant differences in achievement between males and females. To this date, however, there are no studies that explicitly examine and compare the effect of gender on achievement in learning contexts where collaborative and cooperative teaching methods are applied distinctively and explicitly, particularly in DGBL contexts. Overall, the literature on gender differences briefly summarized above clearly shows more focus on gender effect in relation to gender composition, cooperative and competitive learning environments, or specific cooperative learning strategies (e.g., jigsaw) and less emphasis on comparing specific key variables such as achievements and attitudes between cooperative and collaborative learning environments.

Nonetheless, gender remains a fundamental characteristic that underlies the behavior, feelings, and attitudes of male and female students, particularly when video games are involved. Empirically, Bonano and Kommers (2008) found that males have more positive attitudes towards gaming than females. In another study, Kimmons, Liu, Kang, and Santana (2012) examined students' gender and attitudes towards a simulation game and found that girls experienced better learning improvement and showed more positive attitudes toward the game than boys. Moreover, the study by Joo (2017) revealed that gender and student group work preference were related to university students' contributions to the group. Specifically, it was shown that female students were more involved in group work compared to males and that students who reported a preference for group work had the higher contributions. However, it is unclear whether these differences are likely to transfer to younger students in game-based learning environments.

3. Methods

3.1. Participants

One hundred sixty-four, sixth-grade students from five different classes at an elementary school located in South Korea participated voluntarily in this study. All participants were enrolled in a computer and vocational art class at the time of this experiment. For this study, all classes were moved to the last 6th period. Following a gender-balanced approach, students were randomly assigned to either a cooperative group or a collaborative group. All the resulting 41, mixed gender groups included two boys and two girls Twenty groups were assigned to collaborative groups, and the other twenty groups were assigned to cooperative conditions. One group that consisted of one boy and three girls was subsequently removed from data analysis due to the unbalanced gender ratio. Participants played Minecraft after school for one hour per day, four days a week for five weeks. In total, students dedicated about 20 hours of gameplay for this study.

3.2. Procedures

About 85 percent of participants indicated that they had had previous experience playing Minecraft. Nonetheless, both collaborative and cooperative groups participated in an information session about how to play the game. For the novice and inexperienced students, an additional 20-minute training session was provided to explain the basics of how to play and build in Minecraft.

On the first day of week 1, the researchers briefed participants on the gaming and learning activities. The purpose and process of the study were explained briefly. This included the explanations on collaborative and cooperative activities, data collection and achievement scores. On that same day, the attitudes towards games and the feelings towards group work scales were administered. On the second day of the first week, participants were given instructions on how to play Minecraft and had the opportunity to explore Minecraft tutorials. They were also instructed on how to complete the tasks and how to work together based on their gaming conditions (i.e., collaborative versus cooperative). On the third day, all members from both grouping conditions engaged in group discussions and agreed on their assigned roles and individual contributions to the group. By the fourth day of this experiment, all groups were assigned the following game tasks: a) to build a tile house, and b) to build a thatched house in a Minecraft virtual environment (Figure 1). However, before engaging in building tasks, participants were required to gather information and resources about the two types of traditional houses from the olden times of Korea using both the internet and the provided books.

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Two computer labs were made available to accommodate all participating groups. All participants had their own computers (i.e., four computers per group) and they interacted both face-to-face and online while playing Minecraft. On the last day of the fifth week, a knowledge test (used as academic achievement) on the two traditional Korean houses was administered to all participants. Four teachers participated in the grading process. An achievement score for each group represents an average score of the four students within the group.

3.3. Collaborative and Cooperative Gaming Conditions

Both collaborative and cooperative groups were asked to build two types of traditional Korean houses in Minecraft: a tile house commonly associated with the upper class and a thatched house, which is commonly utilized by the lower class (Figure 1).

A tile house A thatched house

Figure 1. A tile and a thatched house

Before gameplay, participants had to identify essential characteristics about the two types of houses based on their research from the books and the internet. They were also asked to compare the two kinds of houses regarding size, rooms, and specific architectural characteristics. For both grouping conditions, the game goal was to build and replicate the two structures in the Minecraft environment.

To create distinct grouping conditions, participants in cooperation had to perform different sub-tasks throughout the activity than those in collaborative conditions. For instance, when searching for information about the two houses, two members of a cooperative group searched and gathered information about the tile house, while the other two members searched for information on the thatched house. For each type of house, one student searched for information on structural elements, and the other searched for information on design characteristics. In other words, all four students within a cooperative group had a unique and different task to complete. Upon completion of this initial task, four students in a cooperative group shared their findings with one another.

For the collaborative groups, all four group members worked simultaneously on the same tasks. For example, they all searched for information on the tile house at the same time. Participants in collaborative conditions provided a summary of findings based on their research within the group. It is important to note that all groups, regardless of grouping conditions, had the same amount of time to complete this initial activity as well as the gaming activity.

A similar approach was taken in the design phase of the gaming activity. For example, in cooperative groups, two students built the tile house while the other two built the thatched house. For each type of house, each participant had a unique role in the building process. For the collaborative conditions, all group members participated in building two houses and performed the same tasks simultaneously. In order to make sure that all members collaborate, they spent the same amount of time, taking turns in building two houses. This building part of the activity lasted for three weeks.

3.4. Instruments

3.4.1. Attitudes Towards Games Scale

Chang, Kuo, and Liu (2014) developed a revised Computer Game Attitude Scale (CGAS) based on a New Computer Game Attitude Scale (NCGAS) which was previously developed by Liu, Lee, and Chen (2013). Since the revised version of CGAS was designed for early adolescents, some items from the NCGAS were removed and reworded so that the revised items could be used by elementary school children (LiuChoi et al., 2013). As a result, the revised Computer Game Attitude comprises 17 five-point-Likert Scale items (5= Strongly Agree; 1= Strongly Disagree) within three subscales: cognition, affection, and behavior.

The cognition subscale includes two factors, confidence and learning. Each factor contains four items measuring users' confidence and positive impact when playing a computer game in learning. The affection subscale of the Revised CGAS contains four items examining the liking factor or perceived enjoyment for playing computer games. The third subscale, behavior, includes five items aiming to measure the leisure factor or how players perceive computer games as leisure activities. Cronbach's alpha for the cognition subscale was .882, .748 for the affection subscale, and .754 for the behavior subscale (Liu et al., 2013). Therefore, this is a valid and reliable scale for attitudes towards games.

3.4.2. Feelings Towards Group Work Scale

The feelings towards group work (FTGW) scale by Cantwell and Andrews (2002) was used in this study to measure participants' feelings towards group work. The original questionnaire consists of 30 items, which are measured on a 5-point Likert scale from 1 (not at all true of me) to 5 (very true of me). The FTGW comprises three domains: preference for individual work, preference for group work, and discomfort in group work.

The first domain, preference for individual work, consists of seven items with a Cronbach's alpha .78. This domain measures participants' feelings of dissatisfaction with group work, their perceptions of whether group work is confusing and less effective than individual work, and their preference to work alone. Lack of involvement and enjoyment in group situations are also addressed in this domain. The eight items on preference for group work, which is the second domain assess students' sense of commitment in group work situations, sense of enhanced understanding, enjoyment in sharing responsibilities and credit for group achievements, and personal contribution to work combined with a preference for choice in groups. The Cronbach's alpha for the preference for group work domain is .71. The four items on discomfort in group work, which is the third domain, aimed to assess students' sense of discomfort when working in groups, feelings of nervousness in group settings, fear of asking for help, and difficulty understanding the nature of the group task. The Cronbach's alpha for the discomfort in group work domain is .60. For this study, the third domain, the discomfort in group work, was not used in the analysis due to its low reliability.

3.4.3. Academic and Gaming Achievements Tests

The academic achievement test consisted of 19 items in three domains: terminology, structures, and characteristics of both a tile and a thatched house. To establish validity of the academic test, social studies teachers were asked to review 19 items for their relevancy and representativeness for two houses' characteristics. Minor edits and item revisions were made after teachers' review. In addition, it was checked that no participants learned about a tile and a thatched house yet in schools. Thus, any details of the two houses were unknown to them yet in the school curriculum. The full score for the academic achievement test was 84 points. Sample question items are presented below:

a. What is the roof of a tile house made of? (Write your answer, 3 points)
b. The source of a tile is the soil. (True or False, 2 points)
c. List all the materials needed to build a thatched house (2 points for each item listed, maximum is six materials).

Four trained teachers evaluated the two traditional houses built in Minecraft as group gaming outcomes and a score for each group was obtained to reflect the gaming achievement. The inter-rater reliability for the gaming achievement test by *Pearson*'s correlation coefficient was .94. The full score for the gaming achievement was 100 points with 50 for each type of house. Below are the six items used to assess a tile house:

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a. Does the roof have a shape of tile? (5 points)

b. Does the wall have a realistic shape, and is it of good quality? (5 points)

c. Is the tile house well made? (15 points)

d. Is the annex constructed well? (15 points)

e. Does it have a yard? (5 points)

f. Does it have a garden? (5 points)

Figure 2 shows a tile and a thatched house built in the Minecraft environment.

A tile house　　　　A thatched house

Figure 2. A tile and a thached house built in Minecraft

3.5. Research Design and Statistical Analysis

In order to test the main effects of two independent variables and their interaction effect, this study applied a 2 x 2 factorial design. Main effects and interactions do not depend on one another. That is, there can be one or two main effects, and an interaction can occur in combination with either main effect, both main effects, or no main effects (Maxwell, Delaney & Kelley, 2018). This two-way ANOVA allows to look for any combined effects of two variables with gender and grouping in this study. Any interaction imply that the two independent variables combine to have a different effect on the academic and gaming achievements. To test homogeneity of participants in terms of the attitudes towards games and the feelings towards group work, a t-test was performed on the pretests before the game play. The research process with design is presented in Figure 3.

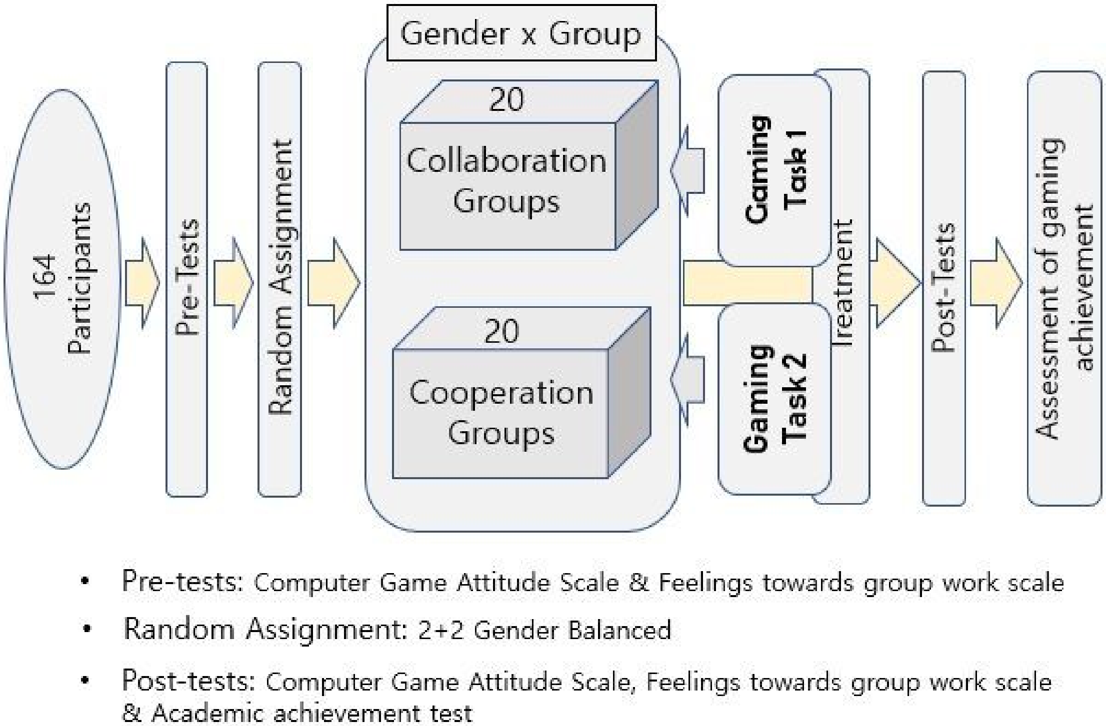

Figure 3. The Experiment Procedure with Research Design

4. Results

To check the homogeneity of participants according to gender and the two grouping conditions in terms of the attitudes towards games and the feelings towards group work, Mann Whitney U test in SPSS was applied on the two pretest scores. This was because the normality of the two tests could not be assumed and the data was gathered on an ordinal scale. The results show that male and female students were not significantly different in the attitudes towards games with U scores of 2729.500 (p=.278), 3162.500 (p=.107), 2863.000 (p=.898), and 3197.000 (p=.992) in the cognitive-confidence, in the cognitive-learn, in the affection-like, and in the behavior-leisure subscales respectively. Additionally, there was no gender difference in the feelings towards group work with U scores of 2305.000 (p=.122) and 2108.500 (p=.323) in the preference of individual work and in the preference of group work respectively.

The collaborative and the cooperative groups did not show any differences in the attitudes towards games with U scores of 3089.500 (p=.705), 3183.500 (p=.955), 3167.000 (p=.910), and 3031.500 (p=.564) in the cognitive-confidence, in the cognitive-learn, in the affection-like, and in the behavior-leisure subscales respectively. For the two grouping conditions, no significant difference was found in the feelings towards group work with U scores of 2985.000 (p=.461) and 3045.000 (p=.596) in the preference of individual work and in the preference of group work respectively. These results suggest that participants were homogeneous in terms of gender and two groupings on the attitudes towards games and the feelings towards group work before they engaged in gameplay for the purpose of this experiment. Lastly, to check the main effects of gender and two grouping conditions, a two-way ANOVA procedure was conducted with post-tests of the attitudes towards games and the feelings towards group work. A test of normality in SPSS using the Shapiro-Wilk test showed the data comes from a normal distribution for the two tests. A t- test was applied to check the difference in gaming achievement between collaborative and cooperative groups.

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4.1 Attitudes Towards Games

To test the main effects of gender and the two grouping on the attitudes towards games, two-way ANOVA was carried out on the posttest scores of the attitudes towards games. The results are presented in Tables 1 and 2.

Table 1

Means and Standard Deviations of the attitudes towards games

Grouping	Gender	Mean	S. D.	N
Collaboration	Male	60.87	15.565	40
	Female	67.23	13.528	40
	Total	64.05	14.837	80
Cooperation	Male	69.83	10.419	40
	Female	57.85	12.027	40
	Total	63.84	12.700	80
Total	Male	65.35	13.909	80
	Female	62.54	13.565	80
	Total	63.94	13.767	160

Table 1 shows that with regards to the attitudes towards games, the means of the collaborative and the cooperative groups are 64.05 and 63.84 respectively. Males had a mean score of 65.35, while females had a mean score of 62.54. Next, to test the main effects of gender and the two grouping conditions on students' attitudes towards games, a 2x2 ANOVA was performed. The actual result, - namely, whether either of the two independent variables (gender and grouping) or their interaction are statistically significant - is shown in Table 2. The particular rows of interest are the "Grouping", "Gender" and "Grouping * Gender" rows. These rows tell us whether the two independent variables (the "Grouping" and "Gender" rows) and their interaction (the "Grouping * Gender" row) have a statistically significant effect on the dependent variable, "the attitudes towards games".

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Table 2.

ANOVA for the attitudes towards games

Source	Sum of Squares	df	Mean Square	F	Sig.
Grouping	1.806	1	1.806	.011	.918
Gender	316.406	1	316.406	1.865	.174
Grouping * Gender	3358.056	1	3358.056	19.798	.000
Error	26460.225	156	169.617		
Total	684345.000	160			

a. R Squared = .122 (Adjusted R Squared = .105)

As shown in Table 2, there is no main effect of gender (F=1.186, $p > .05$) and the grouping conditions (F=.011, $p > .05$) on the attitudes towards games. Thus, H1a and H1b are supported. However, an interaction effect exists (F=19.798, $P < .01$) (Figure 4), which does not support H1c. This interaction effect suggests that, in relation to the attitudes towards games, collaboration is effective among females (Mean Difference is 9.38, t = 3.276, df=78, p < .01) and cooperation is effective among males (Mean difference is 8.96, t = 3.022, df = 78, p < .01).

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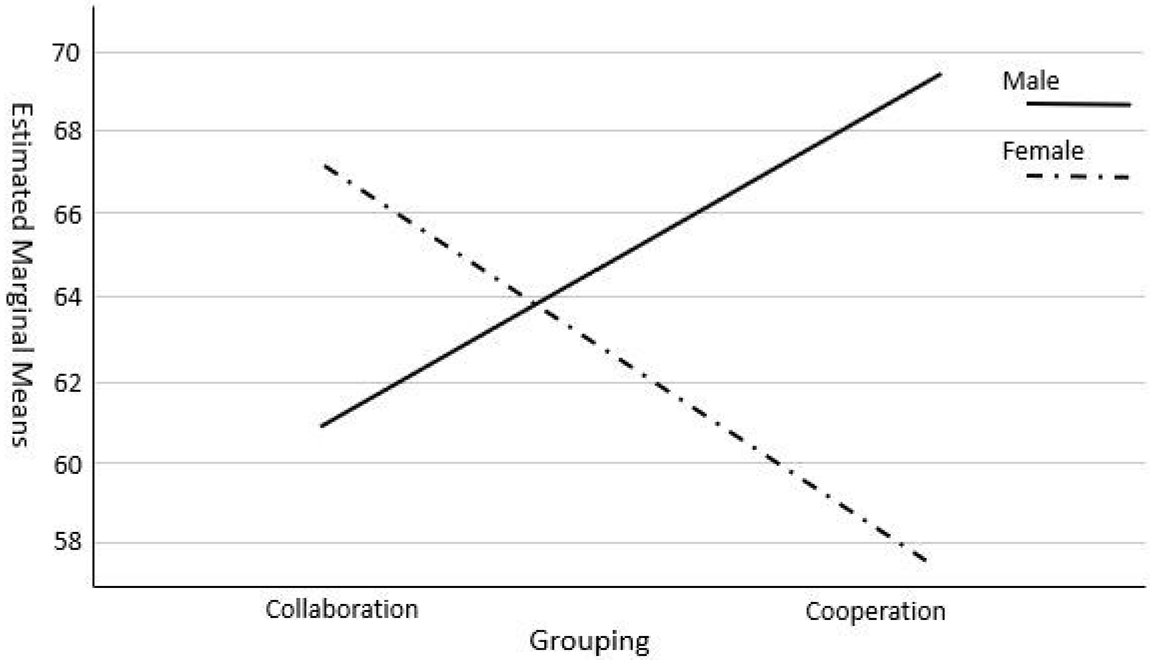

Figure 4. Means of the attitudes towards games

4.2 Feelings Towards Group Work

The feelings towards group work survey consists of three subscales: preference of individual work, preference of group work, and discomfort in group work. For a more thorough analysis, we tested the effects of gender and the two grouping conditions on each of the three dimensions using a two-way ANOVA. Results of the effects of gender and grouping conditions on the first subscale (i.e., preference of individual work) are presented in Tables 3 and 4.

Table 3.

Means and Standard Deviations of the preference of individual work

Grouping	Gender	Mean	S. D.	N
Collaboration	Male	25.55	4.777	40
	Female	26.53	5.458	40
	Total	26.04	5.120	80
Cooperation	Male	23.95	6.206	40
	Female	27.13	3.770	40
	Total	25.54	5.346	80
Total	Male	24.75	5.561	80
	Female	26.83	4.671	80
	Total	25.79	5.224	160

Table 3 shows that regarding the preference of individual work, the means of the collaborative and the cooperative groups are 26.04 and 25.54 respectively. The mean score for males was 24.75 and the mean score for females was 26.83. Next, to test the main effects of gender and the grouping conditions on the students' preference of individual work, a 2x2 ANOVA was performed. The results are shown in Table 4.

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Table 4.

ANOVA for the preference of individual work

Source	Sum of Squares	df	Mean Square	F	Sig.
Grouping	10.000	1	10.000	.0380	.539
Gender	172.225	1	172.225	6.540	.012
Grouping * Gender	48.400	1	48.400	1.838	.177
Error	4108.150	156	26.334		
Total	110738.000	160			

a. R Squared = .053 (Adjusted R Squared = .035)

According to Table 4, there is a main effect of gender on the preference of individual work (F=6.540, $p < .05$). However, there is no main effect of the grouping conditions (F= .0380, $p > .05$) while no interaction effect was found (F=1.838, $p > .05$). Thus, in terms of students' preference of individual work, gender is effective. In other words, female students score higher in the preference of individual work than males.

A similar step was followed to test the effects of gender and grouping conditions on the second subscale (preference of group work). Tables 5 and 6 show the means, standard deviations, and results of ANOVA test.

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Table 5.

Means and Standard Deviations of preference of group work

Grouping	Gender	Mean	S. D.	N
Collaboration	Male	26.93	4.576	40
	Female	23.38	5.381	40
	Total	25.15	5.275	80
Cooperation	Male	26.70	5.292	40
	Female	24.70	3.546	40
	Total	25.70	4.588	80
Total	Male	26.81	4.917	80
	Female	24.04	4.577	80
	Total	25.42	4.935	160

According to Table 5, the means of the collaborative and the cooperative groups are 25.15 and 25.70, and the means of males and females are 26.81 and 24.04 respectively. Next, to test the main effects of gender and the grouping conditions on students' preference of group work, a 2x2 ANOVA was performed. The results are shown in Table 6.

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Table 6.

ANOVA for the preference of group work

Source	Sum of Squares	df	Mean Square	F	Sig.
Grouping	12.100	1	12.100	.535	.466
Gender	308.025	1	308.025	13.616	.000
Grouping * Gender	24.025	1	24.025	1.062	.304
Error	3528.950	156	22.621		
Total	107302.000	160			

a. R Squared = .089 (Adjusted R Squared = .071)

Table 6 shows that there is a main effect of gender on the preference of group work (F=13.616, $p < .01$). Thus, H2a is not supported. However, there is no main effect of the grouping (F=.535, $p > .05$) and no interaction effect exists (F=1.062, $p > .05$), thereby supporting H2b and H2c. Thus, regarding the preference of group work, gender is effective. More precisely, males show higher feelings in the preference of group work than females.

4.3 Academic Achievement

To test the main effects of gender and the two grouping conditions on the academic achievement score, a two-way ANOVA was performed. The results are presented in Tables 7 and 8.

Table 7.

Means and Standard Deviations of the academic achievement

Grouping	Gender	Mean	S. D.	N
Collaboration	Male	44.48	9.511	40
	Female	48.98	9.431	40
	Total	46.72	9.680	80
Cooperation	Male	44.60	12.395	40
	Female	41.55	12.264	40
	Total	43.08	12.347	80
Total	Male	44.54	10.977	80
	Female	45.26	11.494	80
	Total	44.90	11.209	160

According to Table 7, the means of the collaborative and the cooperative groups are 46.72 and 43.08 respectively, and the means of males and females are 44.54 and 45.26 respectively. To test the main effects of gender and the grouping conditions on the academic achievement score, a 2x2 ANOVA was performed. The result is shown in Table 8.

Table 8.

ANOVA for the academic achievement

Source	Sum of Squares	df	Mean Square	F	Sig.
Grouping	532.900	1	532.900	4.409	.037
Gender	21.025	1	21.025	.174	.677
Grouping * Gender	570.025	1	570.025	4.716	.031
Error	18854.450	156	120.862		
Total	342540.000	160			

a. R Squared = .056 (Adjusted R Squared = .038)

According to Table 8, there is no main effect of gender on academic achievement score (F= .174, $p > .05$), Thus, H3a is supported. However, there is a main effect of the grouping conditions (F=4.409, $p < .05$) and an interaction effect is present as shown in Figure 5 (F=4.716, $p < .05$). Thus, H3b is supported while H3c is not supported. In other words, regarding the academic achievement score, collaboration is effective among females and cooperation is effective among males.

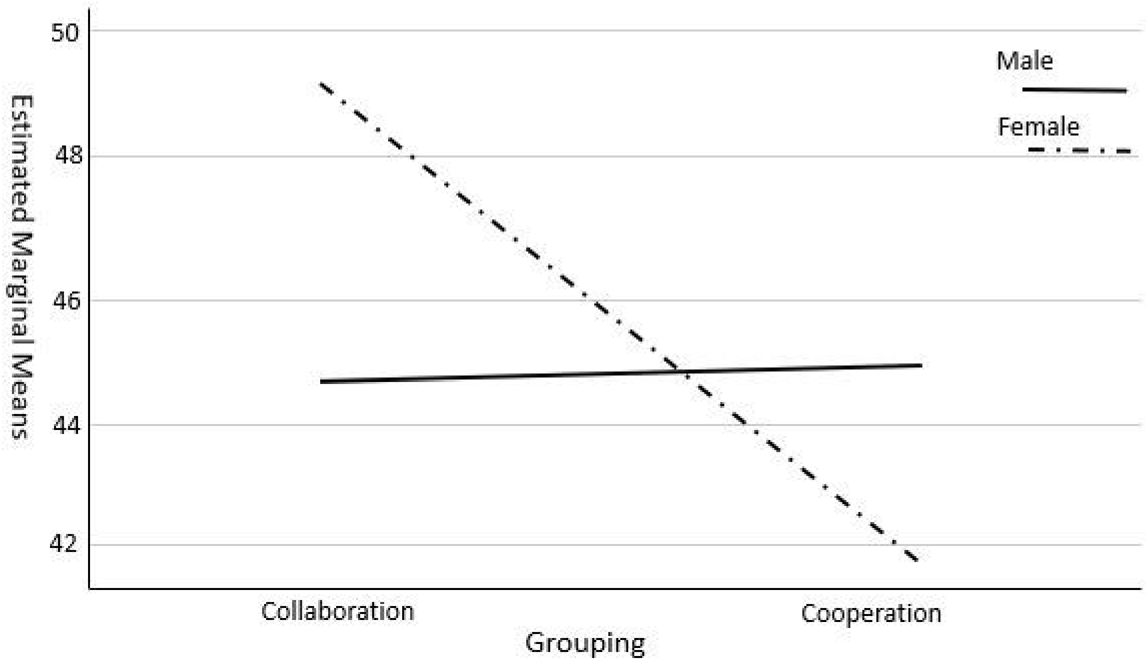

Figure 5. Means of the academic achievement

4.4 Gaming Achievement

Lastly, to check whether there is a significant difference in the gaming achievement between the collaborative and the cooperative groups, a t-test was performed and the result is shown in Table 9.

Table 9.

t-test for two groups' gaming achievement

Grouping	N	Mean	S. D.	t
Collaboration	80	87.20	9.749	2.293*
Cooperation	80	83.61	10.055	

df = 158, * $p < .05$

Results from Table 9 show that collaborative groups have a higher mean in the gaming achievement, which is statistically significant (t=2.293, df=158, p <.05). This means that collaboration is more effective in the gaming achievement than cooperation. Thus, H4, which predicted no significant difference in gaming achievement scores between cooperative and collaborative groups, is not supported in this study.

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5. Discussion and Conclusion

This study was an important first step towards understanding the impacts of collaboration and cooperation, as two exclusive categories, on students' achievements and attitudes in a social game-based learning environment. More specifically, we have examined the effects of gender as well as collaborative and cooperative learning strategies on students' attitudes towards games, feelings towards group work, and achievements (both gaming and academic) when learning with Minecraft. In line with most previous studies on cooperation in educational games, the current study employed the concept of assigning different roles to students in cooperative conditions to emphasize personal accountability and promote positive interdependence. In collaborative conditions, students performed similar tasks and interacted simultaneously to achieve a common goal. The findings of the study are discussed with regard to the two research questions we intended to address.

According to the study results, there was no overall effect of gender and grouping conditions (i.e., collaborative versus cooperative conditions) on students' attitudes towards games. However, there was an interaction between the two suggesting that female students would experience positive effect of collaboration on their attitudes towards games, while data suggest that male students would experience positive effect of cooperation on their attitudes towards games. In other words, the similarity of tasks performed within groups seems to improve female students' game attitudes, whereas assigning different roles appears to improve male students' game attitudes. This is an important finding in that previous empirical research (Touati & Baek, 2017; Wu & Liu, 2007) has indicated a direct relationship between game attitude and enjoyment, while the latter variable was shown to predict academic achievement (Ahmed, van der Werf, Kuyper, & Minnaert, 2013). In a sense, providing adequate grouping conditions based on gender preferences could foster positive attitudes towards educational games, thereby making learning with digital social games more enjoyable. Nevertheless, we recommend that future studies explore the differences in enjoyment levels between male and female students in cooperative and collaborative learning conditions, which could provide more insight into the gender differences in collaboration and cooperation.

The results of this study also indicated that only gender affected students' feelings towards group work. Female students reported greater preferences for working individually while working in groups, while male students reported a higher preference for working in groups. From one perspective, this is inconsistent with the argument that female students have a greater tendency to be team players because they score higher than men on certain personality traits such as extraversion, agreeableness, and selflessness (Budaev, 1999; Costa, Terracciano, & McCraem, 2001; John, Naumann, & Soto, 2008) and also on cooperation and initiative (Johnson & Smith, 1997). In another related study, Joo (2017) found that female students reported greater involvement in group work and suggested a relationship between the aforementioned personality traits and enjoyment of social interactions, as well as the tendency to trust and help other group members. Our results, however, suggest that female students, regardless of the grouping conditions, may not have enjoyed the social interactions within their groups, thus possibly affecting their involvement in group work. Despite the contradiction between our results and previous closely-related investigations, our findings support previous claims that female students' performances in collaborative learning may be sensitive to context (Underwood, 2003). For example, Lee (1993) explored group composition and interactions in a computer-based cooperative learning environment and reported significant differences between single gender groups and mixed-gender groups. Specifically, female students in girl-only groups showed increased interactions, a willingness to ask others for help, and a willingness to help their teammates. In mixed-gender groups, however, female students seemed to interact less with other group members. In another case, Webb (1991) reported that in mostly-male groups, male teammates are more likely to ignore female group members and not answer their questions when they seek answers or explanations. Similarly, the finding that male students showed higher feelings in the preference of group work could be explained in light of a previous study (Carli, 2001), which found that in mixed-sex groups, male students had more influence than female students. The study also showed that male students' contributions received more attention within the group. In the context of our current study, this could explain why male students show higher feelings towards group work because their in-group contributions may have received more attention by their teammates. We suggest that future investigations should focus on the effect of group composition on students' feelings and attitudes towards group work in both collaborative and cooperative learning conditions, particularly in the context of digital social gaming.

As mentioned earlier, our results show no overall effect of gender and grouping conditions on academic achievement. However, there was an interaction effect suggesting that male students would score higher in academic achievement in cooperative learning, while data suggest that female students would show higher academic achievement scores in

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collaborative learning. This finding is consistent with a previous study (Amedu, 2015) which found that boys achieved significantly higher than girls when taught using the jigsaw strategy, a well-known cooperation method. Another interesting finding is in relation to the use of gender-balanced groups in the context of our study. At least two studies (Peklaj, 2003; Petersen, Johnson, & Johnson, 1991) showed that gender did not affect students' achievement in cooperative learning settings when the number of boys and girls was balanced, which is inconsistent with our results. In our case, male students seem to have performed well in conditions where they were assigned different roles. Nonetheless, this finding highlights a promising focus for future studies due to conflicting results in the literature about the impact of gender balance on achievement in cooperative learning conditions.

An interesting finding that is noteworthy is that girls scored higher in academic achievement in collaborative conditions despite their preferences for working individually, which we believe resides in the current research design. Specifically, students were told that their academic performance would be assessed individually, even though they would be working in a group. As mentioned earlier, students in collaborative group conditions worked simultaneously on the same subtasks, which included searching for information on different types of houses as well as providing and constructing summaries of findings together. One possible explanation is that girls may have experienced the most significant learning gains at this stage of the activity, which does not involve online interactions within the virtual world. These learning gains are evidenced by female students' higher academic achievement scores in collaborative conditions compared to cooperative conditions, which involve more independent work from students.

Therefore, it is possible that girls may have initially had positive feelings towards group work but experienced a shift in their attitudes when they engaged in digital gameplay with boys in their groups. Many studies highlight gender differences with regard to social interaction in online gaming. More specifically, research shows that online female players show more social behaviors, participate in group discussions, and seek help more than their male counterparts (Choi, Jung & Kim, 2012; Hong & Hwang, 2012; Hou, 2012; Yee, Bailenson, Urbanek, Chang, & Merget, 2007). Male players, on the other hand, are more goal-oriented (Gefen & Ridings 2005) and competition minded (Li & Su 2013) when playing games online. Literature also points out to performance-related differences between males and females when playing online. Additionally, male players show better spatial skills (Tippett et al., 2009), unlike female players who not only tend to perform inaccurately when placing targets on the map but also may require more time with navigation tasks (Tlaukaa et al., 2005). Therefore, this latter aspect could have easily exacerbated male students' social behaviors towards their female peers in light of Hong and Hwang's (2012) finding that boys are more likely to use negative expressions towards peers. More importantly, this perspective further supports our previous argument about the possible effect of group composition on female students' social interactions within the group. We believe that girl players would show more positive feelings towards group work in a girl-only group merely because the types of interactions female players seek in online gaming are different than those of male players. These are nuanced dynamics; therefore, a qualitative examination of the discourse in groups of both collaborative and cooperative conditions is needed to better understand and elaborate on how these outcomes may have occurred.

Lastly, one aim of this study was to explore and compare gaming achievements in cooperative and collaborative conditions. Results show that collaborative groups achieved significantly higher than cooperative groups. Collaborative gaming provides a context for students to work with each other and solve problems simultaneously, unlike in cooperative gaming where students work interdependently on individual sub-tasks. In the case of a digital social learning game, collaborative problem solving seems to be relevant and effective in relation to achieving a common goal. Our findings are in line with the notion that collaborative problem-solving leads to better performance when compared to individual work, in the sense that cooperative conditions require students, to some extent, to perform subtasks individually rather than as a team. For example, it was shown that a pair of students can outperform an individual student when simulating scientific discoveries (Okada & Simon, 1997) and that four-person groups can outperform the best of four independent individuals (Laughlin, Bonner, & Miner, 2002). Results of our study confirm that collaborative game-based learning, which involves synchronous communication, symmetry of roles, and collective problem-solving tasks may create better conditions for higher group performance than cooperative learning where students work interdependently. Our results are also consistent with previous findings (Beznosyk et al., 2011) which suggest that collaboration in gameplay is a more natural way of working collectively as a team than cooperative approaches in that it requires participants to communicate regularly to complete tasks. In previous research related to computer- supported collaborative learning, Strijbos, Martens, Jochems, & Broers (2004) explored the impact and effectiveness of roles on online students' group performance and found no effect of functional roles on group performance and grades when they compared role and non-role conditions when working in groups. Interestingly, their findings suggest that students in role conditions are more likely to experience intragroup conflicts and drop out

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of the course. From this perspective, the higher outcomes of the gaming achievement in collaborative conditions can be linked to the nature of the conflicts that may arise when working as a group. In other words, goal-oriented conflicts can lead to better group performances as these types of conflicts can usually lead to more participation and more thoughtful decision making (Griffith, Mannix, & Neal, 2003). We believe that constant communication in collaborative conditions also plays an essential role in how conflicts are managed in that students can tackle smaller issues instantly and provide feedback to each other to achieve common goals.

The current study is not without limitations. One important shortcoming stems from the lack of qualitative analysis; thus, our analysis may lack more detailed insights into group processes and student perspectives. Therefore, we recommend that similar future studies should focus on using mixed method analysis to provide more insight into students' perspectives of collaboration and cooperation in digital social games. Secondly, the nature of the sample puts some limitations on the generalizations of these findings. That is, participants' nationality and cultural characteristics could have affected students' attitudes and behaviors in the group work process. Lastly, this study did not test any gender differences with regard to individual gaming achievements as the latter was measured as a group performance.

In summary, this study was the first to examine gender differences in cooperative and collaborative game- based learning in relation to students' feelings, attitudes, and achievements. Given the recent increases of digital social games in the classrooms and the conceptual inaccuracies of group-learning approach terminologies in educational research, having a more current and accurate picture of how grouping conditions affect boys and girls in digital game-based learning is crucial. The practical implications of the results of this study are clear. It is important for teachers and other practitioners interested in the implementation of digital social games to understand how to organize groups to optimize students' performances and achievements. Our findings suggest that in gender-balanced groups, collaborative conditions may promote better gaming achievements for the group. As for individual academic achievements, male students seem to score higher in cooperative conditions while female students achieve better in collaborative conditions. In the current context, Minecraft was used as a social game and students communicated both face-to-face and online; therefore, it is unclear how such grouping strategies may work in other similar games that do not implement the face-to-face component. Another important implication of this study is Minecraft's ability, as a social game, to foster both collaborative and cooperative conditions, thus providing educators with more flexibility to structure learning groups based on role assignments. Lastly, in combination with future research on analyzing and comparing collaboration and cooperation in digital game-based learning, our findings can inform practical teaching decisions about how to structure groups in game-based learning environments more efficiently.

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Table 1

Means and Standard Deviations of the attitudes towards games

Grouping	Gender	Mean	S. D.	N
Collaboration	Male	60.87	15.565	40
	Female	67.23	13.528	40
	Total	64.05	14.837	80
Cooperation	Male	69.83	10.419	40
	Female	57.85	12.027	40
	Total	63.84	12.700	80
Total	Male	65.35	13.909	80
	Female	62.54	13.565	80
	Total	63.94	13.767	160

Table 2.

ANOVA for the attitudes towards games

Source	Sum of Squares	df	Mean Square	F	Sig.
Grouping	1.806	1	1.806	.011	.918
Gender	316.406	1	316.406	1.865	.174
Grouping * Gender	3358.056	1	3358.056	19.798	.000
Error	26460.225	156	169.617		
Total	684345.000	160			

a. R Squared = .122 (Adjusted R Squared = .105)

Table 3.

Means and Standard Deviations of the preference of individual work

Grouping	Gender	Mean	S. D.	N
Collaboration	Male	25.55	4.777	40
	Female	26.53	5.458	40
	Total	26.04	5.120	80
Cooperation	Male	23.95	6.206	40
	Female	27.13	3.770	40
	Total	25.54	5.346	80
Total	Male	24.75	5.561	80
	Female	26.83	4.671	80
	Total	25.79	5.224	160

Table 4.

ANOVA for the preference of individual work

Source	Sum of Squares	df	Mean Square	F	Sig.
Grouping	10.000	1	10.000	.0380	.539
Gender	172.225	1	172.225	6.540	.012
Grouping * Gender	48.400	1	48.400	1.838	.177
Error	4108.150	156	26.334		
Total	110738.000	160			

a. R Squared = .053 (Adjusted R Squared = .035)

Table 5.

Means and Standard Deviations of preference of group work

Grouping	Gender	Mean	S. D.	N
Collaboration	Male	26.93	4.576	40
	Female	23.38	5.381	40
	Total	25.15	5.275	80
Cooperation	Male	26.70	5.292	40
	Female	24.70	3.546	40
	Total	25.70	4.588	80
Total	Male	26.81	4.917	80
	Female	24.04	4.577	80
	Total	25.42	4.935	160

Table 6.

ANOVA for the preference of group work

Source	Sum of Squares	df	Mean Square	F	Sig.
Grouping	12.100	1	12.100	.535	.466
Gender	308.025	1	308.025	13.616	.000
Grouping * Gender	24.025	1	24.025	1.062	.304
Error	3528.950	156	22.621		
Total	107302.000	160			

a. R Squared = .089 (Adjusted R Squared = .071)

Table 7.

Means and Standard Deviations of the academic achievement

Grouping	Gender	Mean	S. D.	N
Collaboration	Male	44.48	9.511	40
	Female	48.98	9.431	40
	Total	46.72	9.680	80
Cooperation	Male	44.60	12.395	40
	Female	41.55	12.264	40
	Total	43.08	12.347	80
Total	Male	44.54	10.977	80
	Female	45.26	11.494	80
	Total	44.90	11.209	160

Table 8.

ANOVA for the academic achievement

Source	Sum of Squares	df	Mean Square	F	Sig.
Grouping	532.900	1	532.900	4.409	.037
Gender	21.025	1	21.025	.174	.677
Grouping * Gender	570.025	1	570.025	4.716	.031
Error	18854.450	156	120.862		
Total	342540.000	160			

a. R Squared = .056 (Adjusted R Squared = .038)

Table 9.

t-test for two groups' gaming achievement

Grouping	N	Mean	S. D.	t
Collaboration	80	87.20	9.749	2.293*
Cooperation	80	83.61	10.055	

df = 158, * $p < .05$

A tile house

A thatched house

Figure 1. A tile and a thatched house

161x66mm (96 x 96 DPI)

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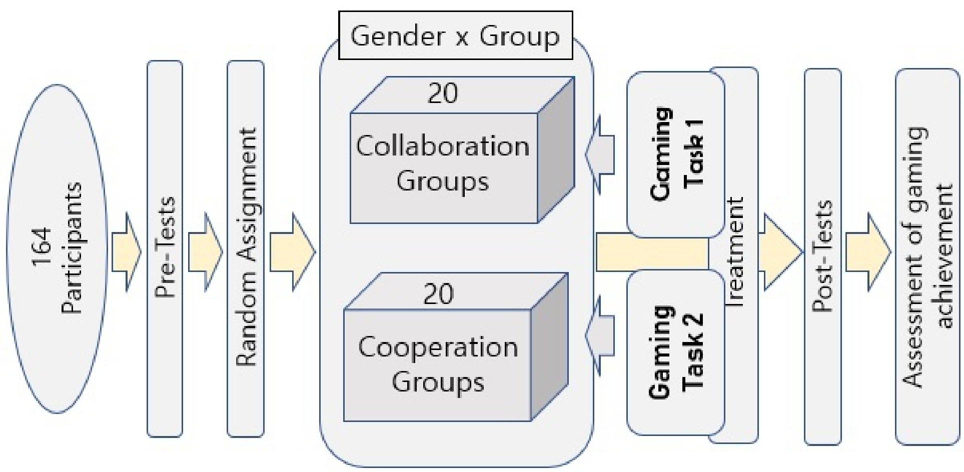
Figure 2. A tile and a thached house built in Minecraft

165x67mm (96 x 96 DPI)



- Pre-tests: Computer Game Attitude Scale & Feelings towards group work scale
- Random Assignment: 2+2 Gender Balanced
- Post-tests: Computer Game Attitude Scale, Feelings towards group work scale & Academic achievement test

Figure 3. The Experiment Procedure with Research Design

165x126mm (96 x 96 DPI)

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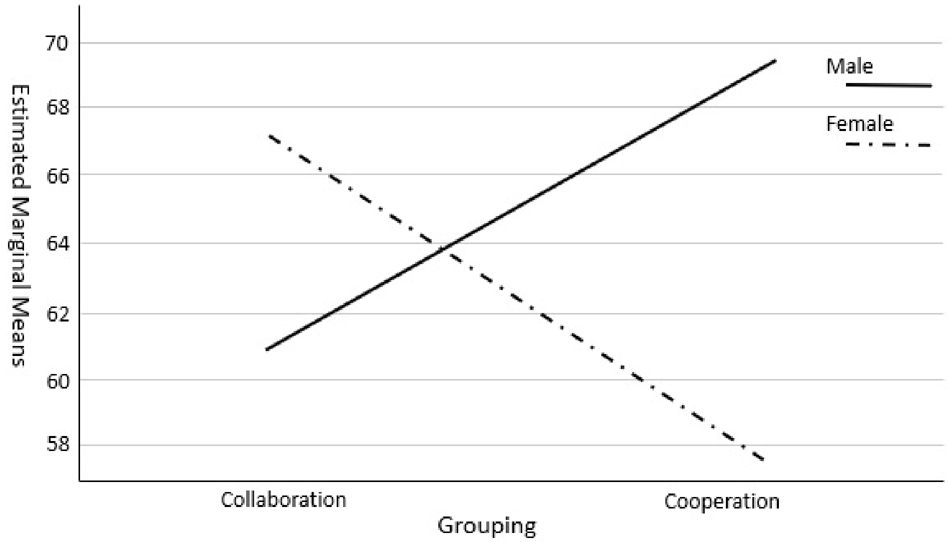

Figure 4. Means of the attitudes towards games

161x106mm (96 x 96 DPI)

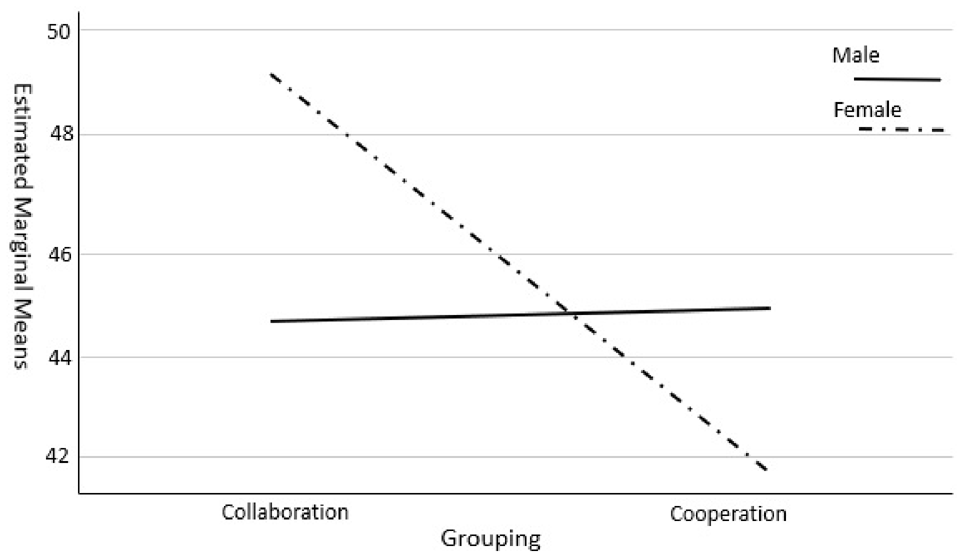

Figure 5. Means of the academic achievement

159x104mm (96 x 96 DPI)