Using Minecraft Education Edition to Enhance 21st Century Skills in the College Classroom: A Mixed Methods Study

Lee, Sungwoong
University of West Georgia
sungwoong@westga.edu

Jang, William
University of West Georgia
wjang@westga.edu

Rollins, Minna
University of West Georgia
mrollins@westga.edu

Abstract

Our study explores how Minecraft: Education Edition could be used to enhance students' social-emotional development at the college level. In this paper, we report on the pilot phase of our study, which includes data from first-year college students in an American university. We used a mixed methods approach involving observing the participants playing Minecraft: Education Edition and surveys before and after the gameplay. Our pilot study explores the impact of collaborative and competitive gameplay on college students' development and enhancement of computational thinking and empathy. We discuss the pilot study results and conclude our paper by outlining the next steps of our project and future research avenues.

Keywords: Esports, Minecraft, social-emotional development, communication, game-based learning, college

1. Introduction

The popularity of both esports and casual gaming has been steadily increasing worldwide. At least one person plays video games for at least three hours a week in more than 60% of U.S. households (Jenny et al. (2018). Wijman (2019) estimated that globally, there were 2.5 billion gamers who spent more than USD 150 billion on video games. Playing video games and competitive video gaming, esports, are not for entertainment only but can be used for education. Our study explores the impact of collaborative and competitive gameplay among college students.

The growth of esports has led to the emergence of varsity esports teams in intercollegiate athletics in colleges and universities across the U.S. With the growth of intercollegiate esports leagues, the educational value of esports team play has increased (Ye et al., 2021), and the universities have been considering esports an academic pursuit because of the keen students' interest in learning more about esports, marketing promotion, and finance (Schackner, 2021). King et al. (2021) state that esports programs in universities can contribute to positive educational outcomes for many college students by providing opportunities for students to integrate their learning in various ways. Private companies have also teamed up with video game designers to create courses and programs on various topics, such as personal finance (Hall, 2019).

There is evidence that involvement in esports helps players develop skills needed in 21st-century societies and is increasingly valued by employers. For instance, Nielsen & Hanghøj (2019) found that esports players themselves viewed that people skills' gained from esports transferred to friends, family, and school work. The World Economic Forum presented skills students can learn by playing esports together, such as critical thinking and analysis, problem-solving, self-management, working with people, and management/communication of activities. According to Tom Dore of the British Esports Federation, like any other school extra-curricular team activity, playing esports as a team can contribute to developing teamwork, leadership, communication, problem-solving, and strategic thinking (Shine, 2023). Additionally, the World Economic Forum report indicated that more exploration into technology's potential role in emotional learning would be needed (Shine, 2023). In the same vein, the leaders of the Central Bucks School District, which consists of fifteen elementary schools, five middle schools, and three high schools in Pennsylvania in the United States, adopted esports to increase students' access and build community (Ullery, 2021).

Despite the growing interest in game-based learning in schools worldwide, research on it in a classroom is still lacking (Chan et al., 2021; Zhong et al., 2022). Researchers have found that game-based learning generally enhances learning outcomes in various educational settings and grade levels (e.g., Hamari et al. 2016). Previous studies have shown the positive impact of gameplay when learning various subjects such as Mathematics and spelling in elementary and middle school grades (e.g., Feng & Caleo, 2000; Eck & Dempsey, 2002; Ke & Grabowski, 2007; Núnez Castellar et al., 2015; Kim & Ke, 2017). Few studies have focused on game-based learning at the college level or among other adult learners. Two studies are

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exceptions; Chan et al. (2021) explored game-based learning in a university Psychology course, and Komatsu et al. (2021) explored how esports could teach various work skills to adult learners.

Further, only a few studies have focused on the social side of learning through game-based learning and esports, what 21st-century skills can be developed through esports participation, and how these skills are acquired (Zhong et al., 2022). Therefore, our study explores the impact of game-based learning on students' 21st-century skills at the college level. In particular, we explore if and how game-based learning can develop computational thinking and empathy in the educational esports theme contest among college students. Our study contributes to the literature on game-based learning among adult learners.

Our study uses Minecraft: Education Edition (MEE) as our platform/game. MEE launched in 2016, is a $5 educational version for educators and learners with Office 365 Education accounts (Minecraft: Education Edition, 2021, November 9). Minecraft is a sandbox video game launched in 2011. The game's purpose is to build, explore, and survive in 3D worlds. Swedish game publisher Mojang released the popular Minecraft game in 2011, and Microsoft acquired Minecraft four years later (Pagliery, 2015). There are more than 140 million active Minecraft users of Minecraft, and it is considered the most successful video game ever developed (Statista, 2022).

2. Conceptual foundation

2.1. Defining esports and esports game boundary

Wagner (2006, p. 439) originally defined esports directly through the lens of traditional sports and information systems: "[esports] is an area of sports activities in which people develop and train mental or physical abilities in the use of information and communication technologies." Jang and Byon (2020) conceptualize esports as a sports competition in the virtual world using human-electronic devices. Competition with clear winners and losers is considered one of the primary features of esports and one of the prerequisites of it. Esports games include an in-game system for winners and losers after the competitions so that players or teams accept the results of matches without a doubt or claim. For example, if there is a video game without specific standards to decide winners or losers, this game would not qualify as an esports game due to failure to meet the competition standard clearly (Funk et al., 2018).

Esports games can be distinguished from non-esports video games with 1) structure (e.g., standard rules in the game), 2) organization (e.g., rule adherence in esports tournaments), and 3) institutionalization of the esports tournaments criteria (Funk et al., 2018). For example, League of Legends is a representative and popular esports game, and the League of Legends World Championship is a highly successful esports tournament. As evidence, in 2019, 100 million viewers watched the League of Legends World Championship via Twitch and YouTube. In comparison, the American Football Championship game, Super Bowl 2019, had 100.7 million viewers across the NFL's digital properties (Roundhill, 2020).

2.2. Esports Competition and Minecraft: Education Edition

In our study, we selected MEE to conduct gameplay and conceptualized MEE gameplay as an esports theme contest. We argue that the most popular esports games, such as Dota 2 or the League of Legends, are not the best learning and classroom use options because of the high levels of toxicity in many esports games (Madden & Harteveld, 2021). In addition, the level of gaming experience and skills required to play them would make game-based learning cumbersome for most participants. When gamers are fully immersed in competition as severe leisure (Seo, 2016), their communication can be toxic in the anonymous environment if they lose the game. We emphasize that we need to distinguish using esports in the classroom to learn 21st-century skills from playing esports as an amateur or professional gamer. Pishchik et al.'s (2019) study about the mental activity of esports players ages 17-20 in Russia, and Ye et al.'s (2021) study from China among King of Glory players focused on serious gamers who played esports in the tournaments. Participants themselves believed that playing esports has cultivated good cooperative attitudes (Ye et al., 2021).

The primary component of esports is competition in the virtual world. The competition is expected to affect education positively, and MEE fits this criterion. Team competition may bring more opportunities for learning, including communication, problem-solving, and collaboration (Minecraft: Education Edition, 2021). Students' cooperation as a team to compete against others helps boost their communication and social-emotional skills.

In an educational and non-anonymous environment, the esports theme context's corporation, teamwork, and competition features could be advantageous for studying socio-emotional skills. MEE focuses on education rather than simply winning the competition. Jonasson and Thiborg (2010) indicated that esports is closer to sport in Guttmann's sports model, play-games-contests-sports. Simply put, those are hierarchical structures, so games are organized

play, contests are competitive games, and sports are intellectual contests.

2.3. Learning computational thinking and empathy through game-based learning

We defined MEE as game-based learning in esports theme, which focuses more on cooperation among team members than competition against opponent team. Rothwell and Shaffer (2019) state that the real-world applications of learning skills, such as communication, teamwork, and high-pressure problem-solving, could be effectively learned through esports. Only recently, the impact of game-based learning and esports on socio-emotional skills has been studied, and only a handful of studies have involved learners 18 years and older. The two studies, Chan et al. (2021) and Zhong et al. (2022), are good examples of studies focused on game-based learning.

Chan et al. (2021) examined the interaction relationship between learning outcomes and perceived flow experience in a two-by-two (competitive and non-competitive x group and individual) experimental design. They found that non-competitive game-based learning in groups promoted better learning outcomes among the participants. Chan et al. (2021) further suggest that a local culture may affect the results. Chan et al. (2021) proposed that the use of game-based learning in the Asian context, which is knowledge-oriented learning, could be optimized by focusing on the utility of game-based learning toward performance monitoring and social learning. Since Chan et al.'s (2021) study was conducted in an Asian academic context, learning outcomes with those perceived flow experiences might differ in the U.S. and other Western cultures.

Zhong et al. (2022) conducted a systematic review of the studies focusing on the impact of esports participation on developing 21st-century skills in youth. They conclude that existing research has focused on developing collaboration and communication skills through playing esports. Only a few studies on adult learners have focused on other life and career skills related to creativity and innovation, information literacy, and citizenship. Furthermore, Zhong et al.

(2022) point out that esports' commonly mentioned negative and dark sides, such as abusive language during the game and gender discrimination, should be tackled to maximize esports' educational benefits. Using MEE, we distinguish between using esports in the classroom for learning 21st-century skills from playing esports and general esports game competition (Zhong et al., 2022). Although there is competitiveness in building better in-game constructions according to the provided themes in MEE, students might perceive the competitions to differ from the severe competitors in popular esports games. Chan et al. (2021) also indicated that non-competitive game-based learning with group activity can optimize learning outcomes. As we conceptualize MEE as an esports theme contest, students feel competitive aspect, and it might help the game-based learning process based on the findings of Chan et al. (2021).

Our study aims to explore the college students' development of 21st-century skills in team-based competitions under the educational esports theme. According to Korkmaz et al. (2017), "many educators and especially the experts in the educational technology field have emphasized that computational thinking is so significant in terms of the skills of the 21st century" (p. 559). The term “computational thinking’ refers to knowledge, skill, and attitudes necessary to solve life problems in production using computers (Korkmaz et al., 2017). Computational thinking is a general frame for computers and everyone's fundamental skills, such as reading, writing, and arithmetical analysis skills.

3. Methods and Data Collection

3.1. Measures used

We adopted six constructs: Creativity, Algorithmic thinking, Cooperativity, Critical thinking, Problem-solving, and Empathy to test in our study. Creativity is defined as the capacity to express oneself to reveal a nonexistent product or solution in daily life. Algorithmic thinking is the skill of understanding, applying, and assessing algorithms, which is a process of problem-solving operations. Cooperativity is cooperative learning as rewarding the set members helping each other to learn an academic subject. Critical thinking is a cognitive strategy to increase the possibility of the desired behaviors, attitudes, or skills to assess a problem status. Problem-solving matches one of the priority goals of education: overcoming the problems encountered in life. The problem is referred to as the general term of troubles that individuals engage in life.

The sixth construct we studied, a socio-emotional skill, empathy, is the ability to feel someone else's feelings and understand their causes (Casse et al., 2023). There are two components of empathy: affective, the ability to feel an appropriate emotional response when confronted with the mental state attributed to another person, and cognitive, the understanding of another person's affective state (Casse et al., 2013).

Tables 1 and 2 show the items for each construct. Table one shows items four variables (i.e., Creativity, Algorithmic thinking, Cooperativity, Critical thinking, and Problem-solving) from the computational thinking scale from Korkmaz et al. (2017). Table 2 includes a

Table 1 Pre- and Post-Game Survey Constructs and Items
Scale used: 1=strongly disagree…5= strongly agree

1. I like the people who are sure of most of their decisions.
2. I like the people who are realistic and neutral.
3. I believe that I can solve most of the problems I face if I have sufficient amount of time and if I show effort.
4. I have a belief that I can solve the problems possible to occur when I encounter with a new situation.
5. I trust that I can apply the plan while making it to solve a problem of mine.
6. Dreaming causes my most important projects to come to light.
7. I trust my intuitions and feelings of "trueness" and "wrongness" when I approach the solution of a problem.
8. When I encounter with a problem, I stop before proceeding to another subject and think over that problem.
9. I can immediately establish the equity that will give the solution of a problem thinking.
10. I think that I have a special interest in the mathematical processes.
11. I think that I learn better the instructions made with the help of mathematical symbols and concepts.
12. I believe that I can easily catch the relation between the figures.
13. I can mathematically express the solution ways of the problems I face in the daily life.
14. I can digitize a mathematical problem expressed verbally.
15. I like experiencing cooperative learning together with my group friends.
16. In the cooperative learning, I think that I attain/will attain more successful results because I am working in a group.
17. I like solving problems related to group project together with my friends in cooperative learning
18. More ideas occur in cooperative learning.
19. I am good at preparing regular plans regarding the solution of the complex problems.
20. It is fun to try to solve the complex problems.
21. I am willing to learn challenging things.
22. I am proud of being able to think with a great precision.
23. I make use of a systematic method while comparing the options at my hand and while reaching a decision
24. I have problems in the demonstration of the solution of a problem in my mind.
25. I have problems in the issue of where and how I should use the variables such as X and Y in the solution of a problem.
26. I cannot apply the solution ways I plan respectively and gradually.
27. I cannot produce so many options while thinking of the possible solution ways regarding a problem.
28. I cannot develop my own ideas in the environment of cooperative learning.
29. It tires me to try to learn something together with my group friends in cooperative learning.

basic empathy scale for adults with 20 items that were adopted from Carré et al. (2013).

3.2. Mixed methods approach

We adopted a mixed methodology approach, combining different data sources in one study. Figure 1 summarizes our data collection process and the data types we collected in our pilot study. We collected data for the pilot study in a first-year seminar course at a U.S. university. MEE is our game of choice (see section 2.2.), and the task was to build pirate-theme objects, such as chests and ships. We used an Ethernet cable for a stable Internet connection. We obtained approval from our home university's IRB before collecting data.

Each participant spent approximately 67 minutes on the surveys, orientation, and gameplay. First, we divided the students into two groups, and then the students logged in to Discord and the group's voice channel. Second, participants were asked to complete the pre-game survey (Table 1 Pre- and Post-Game Survey), which took approximately 10 minutes.

After completing a pre-game survey, participants watched the MEE orientation (5 minutes and 30 sec) and logged in to MEE. The gameplay in MEE lasted 35 minutes. we recorded participants' faces, voices, and in-game playing using OBS (Open Broadcaster Software), an open-source application. The purpose of recording the gameplay was to observe the communication and interaction among the players. Observations provide additional insights into learning and a more objective view of changes. Using Otter.ia, we created transcripts from the recorded session during their cooperative and competitive MEE play. We closed the session with a post-game survey (Table 1) that took approximately 10 minutes to complete.

3.3. Participants profile

We collected our data in the first-year seminar course at an American university. All of our 22 participants, 11 in group yellow and 11 in group green, were American and spoke English as their first language. Participants were 18-20 years old and freshman students. The participants knew each other from the first-year seminar course. One of the participants was female, and the

Table 2 Pre- and Post-Game Survey Constructs and Items
Scale used: 1=strongly disagree…5= strongly agree

1.	My friends' emotions don't affect me much.
2.	After being with a friend who is sad about something, I usually feel sad.
3.	I can understand my friend's happiness when she/he does well at something.
4.	I get frightened when I watch characters in a good scary movie.
5.	I get caught up in other people's feelings easily.
6.	I find it hard to know when my friends are frightened.
7.	I don't become sad when I see other people crying.
8.	Other people's feelings don't bother me at all.
9.	When someone is feeling 'down' I can usually understand how they feel.
10.	I can usually work out when my friends are scared.
11.	I often become sad when watching sad things on TV or in films.
12.	I can often understand how people are feeling even before they tell me.
13.	Seeing a person who has been angered has no effect on my feelings.
14.	I can usually work out when people are cheerful.
15.	I tend to feel scared when I am with friends who are afraid.
16.	I can usually realize quickly when a friend is angry.
17.	I often get swept up in my friends' feelings.
18.	My friend's unhappiness doesn't make me feel anything.
19.	I am not usually aware of my friends' feelings.
20.	I have trouble figuring out when my friends are happy.

others were male.

The data were collected in two days, and we recorded two sections from each team per game. On the first day, four participants played the yellow team, and another four played the green team against the yellow team. There was one match and two recorded sections from each team. On the second day, 12 different participants played a four vs. four and three vs. three competitions. We collected four recorded sections from the two matches on the second day.

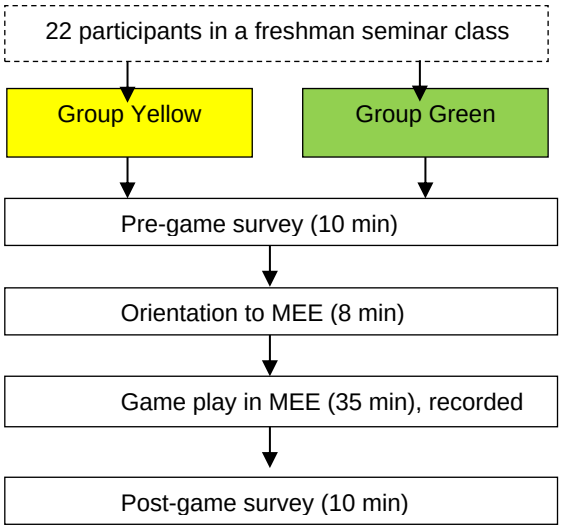

Figure 1 Data collection of the pilot study (total time 67 min)

None of the participants had played esports competitively, but all had played video games before and were familiar with Minecraft. Some participants expressed during the gameplay that they were very good at building things in Minecraft. We will next describe our preliminary results.

4. Preliminary results and conclusions

4.1. The results from the surveys

The pre-and post-game survey data were analyzed with descriptive statistics in SPSS version 27, and the researchers analyzed recorded sessions. First, we computed the average value of the items belonging to each construct to compare the differences between the constructs tested. We used an independent t-test to compare pre- and post-game survey results. The results showed no statistical differences between pre- and post-game for the six variables (i.e., Creativity, Algorithmic thinking, Cooperativity, Critical thinking, Problem-solving, and Empathy). Although there were no statistical differences, the visual graph shows the patterns' changes between pre-game and post-game (Figure 2). The post-game survey's creativity, algorithmic thinking, cooperativity, and critical thinking values were slightly higher than the pre-game survey results. The values of the empathy scale were almost identical in both surveys. While the statistical comparisons do not support the differences, the qualitative analysis supplements the findings - the MEE esports competition may impact participants' computational skills over time.

4.2. The results from the recorded sessions

The second part of the analysis was to analyze the transcripts of the recorded sessions. We had a total of six recorded sessions, and each session was approximately 35 minutes. We analyzed the transcript of the pilot phase and looked for the themes that were included in the pre-surveys.

First, we observed c reativity, the capacity to express oneself to reveal a nonexistent product or

solution daily. Creativity was shown in many ways during the gameplay. The participants had a relatively short time limit to complete the task, 35 minutes; it was essential to begin quickly and decide what the team was building. Within 2-3 minutes, participants planned what they would build and the task for each person. For instance, the participants quickly started coming up with ideas as follows: *"What if we build a giant barrel discord with, I mean, water inside*?" and "*We did like a skull. Yeah, let's make a let's make a treasure chest with some stuff inside of it*." The participants were familiar with Minecraft and were excited about the creative process as one of the participants expressed: *"Theme is a pirate theme. All right, guys. Maybe we can try and make a miniature ship battle like throw down some blue wall on the bottom, put two ships on top of it, shooting cannons at each other*."

The second theme we observed is algorithmic thinking, which refers to the skill of understanding, applying, and assessing algorithms. It is a process of problem-solving operations. Building in Minecraft requires some algorithmic thinking. For instance, one participant pondered this: *"I think the hardest part for this thing isn't even going to be like the details. It's just going to be getting the actual lid of it. So, I'm just gonna try and rush through that and then focus on everything else. Because really we don't have a lot of time."*

The third aspect we observed was cooperativity, which refers to participants helping each other to learn.

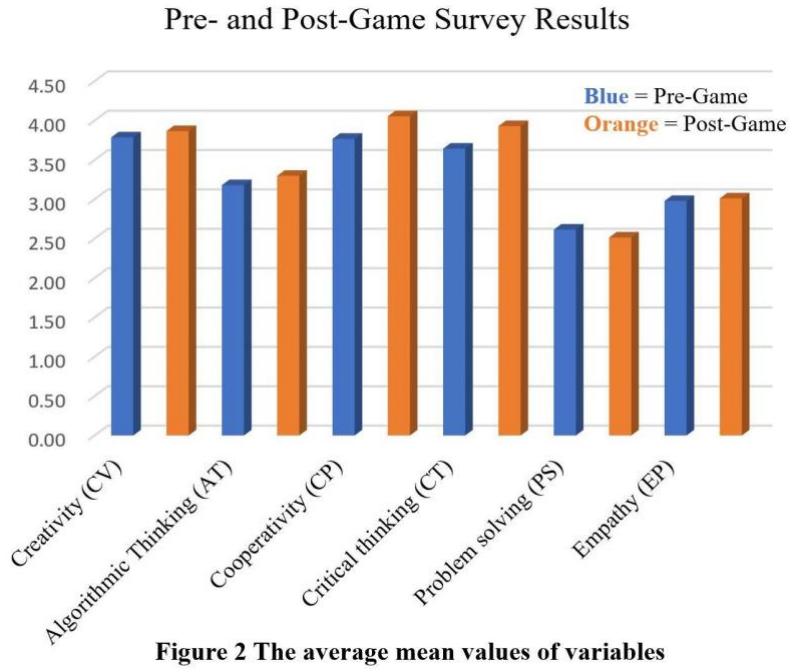

Figure 2 The average mean values of variables

The participants were talking about the designs and how to make things work. *" "I think it's not a cool pirate theme, but, all right, let's do this pirate theme. We could make a big red X"*. Another participant explained: *"I'm going to get started based on where the chest is going to be targeted around this. There will be big chains around it that are about one the other."* One participant was talking about the materials for the ships: *"We can do spruce wood slabs and just tidy this up slightly."* One participant observed another one and asked: *"Are you here going to be made out of wood? It seems a waterbed."* The participants were sharing with each other which part they were going to build, for instance, as follows: *"I'm going to get started on the base for the ship."*

The fourth theme we observed from the gameplay was critical thinking, which is a cognitive strategy to increase the possibility of the desired behaviors. There was a network issue during the gameplay, which caused a lag in connection. We observed critical thinking about the goal of the experiment as follows: *"I thought the goal of this was to be cooperative to make it grow without all the lag; that's the real test for a social person."*

Our fifth theme, problem-solving, defined as overcoming the problems encountered in life, is present in learning in any subject. During the time-restricted gameplay, the participants had to prioritize and solve the problems at hand. One of the participants explained to others: *"I think what will give us an advantage is if we just build something that can get finished in the time that we have. I feel like just having anything finished would be a big bonus, so just focus on giving something a finished quality."*

Last, we observed empathy. Based on the interactions among the teams, participants sounded friendly toward each other during the gameplay. The toxic language common in esports was not used at all. The presence of the professors probably curbed the language. Based on the swift decisions and planning, the participants were relatively knowledgeable and experienced with Minecraft. The participants were also excited about building together. Two of the participants described the final results as follows:

"I just loaded back in, so would you please okay so we made a fleet of ships? Yeah, it's a fleet of ships. One of them got a really big cannon. I think that's pretty cool. Another one has a pretty dope sail the third one is very luxurious. The third was like a tree house; how could you not want that? Oh my god, the third ship has a cozy exterior".

"Since it's the biggest battleship the battleship has made, it definitely possibly got what we call the BAC. The guys made it, and then it's got the underdeck fan and so pretty much prime for more."

4.3. Next steps of the project

Educators have suggested that the real-world applications of learning skills, such as communication, teamwork, and high-pressure problem-solving, could be effectively learned through esports (Rothwell & Shaffer, 2019). Studies with adult learners in game-based learning are rare, and our study aims to contribute to this literature.

The next step of our study is to collect complete data. We will set up the gameplay in several first-year seminar courses in the early fall of 2023. Our main study will include two to three gameplay sessions, approximately one week apart, and pre-post surveys will be conducted before and after the game sessions to see the difference over time. Although our pilot study, pre- and post-game play, did not show statistical differences, the pilot study confirmed the usability of our research design and the technical requirements required to collect data effectively. Collecting several types of data will give more in-depth insights into how college-aged students could learn through esports and how educators could design their gameplay and integrate them into their courses.

5. Future research avenues

The experience and attitudes towards esports and gaming, in general, may play a role in learning esports. Our pilot study had participants only from one national culture, the United States, and we only collected age and gender as demographic information. Chan et al. (2021) noted that their study involved participants from an Asian education context, which may have impacted their view on game-based learning and esports. We will address the diversity of the participants in our main study by recruiting students from different backgrounds and gender. In the pre-game play survey, we will also ask participants' views on esports and gaming. Also, gender differences have been considered a focal factor in esports game-playing consumption (Jang & Byon, 2021). While our pilot study only had one female participant as one of the limitations, future studies may collect data from equal quotas between males and females to examine the gender differences in game-based learning behaviors.

MEE is an easy-to-use game for the educational setting. However, the overall experience with video games may play a role in how participants communicate with each other during the gameplay. In our main study, we plan to compose teams with players with various levels of experience in esports and gaming to increase communication and problem-solving activities among the participants.

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