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I-CReST 2025:146-106 – Gamifying Mathematics: Investigating the Relationship Between Self-Efficacy and Affective Engagement via Minecraft Education Edition

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ABSTRACT

This study explored the relationship between secondary student's self-efficacy and affective engagement in mathematics with the use of Minecraft Education Edition as a tool for gamification. Under the theoretical framework of Bandura's Social Cognitive Theory, the study was conducted to measure the self-efficacy and affective engagement along with the relationship between the two. A mixed-methods approach with 94 Form Four students was conducted which included interviews and a survey with seven items on self-efficacy and six items on affective engagement (high reliability, 4-point Likert scale). The findings indicated that both affective involvement (Mean=3.25, Standard Deviation=0.43) and self-efficacy (Mean=3.19, Standard Deviation=0.40) were at relatively high levels. However, there was no statistically significant relationship reported between these two variables (r=0.160, p=0.124). This implies that although, self-confidence and engagement may be positively related through Minecraft Education Edition at the individual level, the linear relationship between them in this case needs to be examined. The study highlights gamification's potential in mathematics education.

Keywords: Minecraft Education Edition; gamification tool; Bandura's Social Cognitive Theory

1. INTRODUCTION

Gamification has developed as a powerful and engaging approach in various fields, such as education, training, and advertising. In context of education, gamification is the process of incorporating gaming elements into educational environments to improve engagement, academic performance and motivation. One such gaming platform gaining popularity is Minecraft Education Edition, a sandbox-based digital platform that enable students to construct, explore, and engage in virtual environments that are in line with educational objectives.

To solve enduring challenges in mathematics education, such as students' lack of self-esteem, motivation and disengagement, educators have recently increasingly explored gamified learning. Even though cognitive performance is frequently emphasized, emotional and psychological factors, like self-efficacy and affective engagement, are just as important for students' academic achievement, particularly in mathematics, a subject that is frequently seen as challenging and anxiety-inducing. According to Bandura's Social Cognitive Theory, self-efficacy refers to an individual's belief in their capacity to accomplish objectives and overcome academic challenges. Affective engagement, on the other hand, captures students' emotional

involvement, such as interest, enjoyment, and excitement for learning activities. Both characteristics significantly predict student motivation and learning outcomes.

However, there is limited study examining how gamification tools, such as Minecraft Education Edition, improve self-efficacy and affective engagement in learning mathematics, despite their growing use. Additionally, the possible relationship between these two variables remains under-investigated.

This study aims to address this gap by assessing the level of students' self-efficacy and affective engagement when learning mathematics using Minecraft Education Edition and evaluating the correlation between the two. The findings are intended to give insights for educators and policymakers into the effectiveness of gamification in fostering positive learning environments in secondary education.

2. LITERATURE REVIEW

2.1 Theoretical Background

Bandura's Social Cognitive Theory, which describes how people learn by interacting their thoughts, behaviours, and environment, serves as the foundation for this study. Self-efficacy, or the belief that one can succeed in a certain task, is one of the fundamental ideas [1]. Bandura identifies four primary sources of self-efficacy: verbal encouragement, emotional responses, mastery experiences, and observing others.

2.2 Gamification in Education

Gamification is the process of adding elements of games, including missions, levels, or rewards, to non-gaming activities to make them more interesting. Gamification has the potential to improve student engagement, motivation, and performance in the classroom [2, 3, 4]. One of the most popular gamified educational resources is Minecraft Education Edition. It enables students to construct, investigate, and resolve issues in an imaginative virtual environment. Research has indicated that Minecraft enhances digital abilities, creativity, and teamwork [5]. It can also be used by teachers to create engaging classes that align with curricular objectives.

2.3 Self-Efficacy in Mathematics

High self-efficacy students are more confident, attempt more difficult problems, and continue to learn even faced with challenges [6]. Games like Minecraft let students practice skills without worrying about failing and can help them develop confidence. When students get immediate feedback and have chances to succeed, their belief in their abilities improves [7].

2.4 Affective Engagement in Mathematics

Affective engagement refers to students' emotional involvement in learning, such as their feelings of excitement, curiosity, or happiness. In learning mathematics, where many students experience anxiety and feel fear, it is particularly crucial [8]. Students typically like studying more and perform better when they are emotionally involved [9]. It has been reported that using Minecraft increases students' interest and enjoyment of learning mathematics [5, 10]. It helps them to stay focused by making learning more engaging and participatory.

2.5 Relationship Between Self-Efficacy and Affective Engagement

According to recent research, affective engagement and self-efficacy are connected. Students who are emotionally involved tend to feel more confident, and those who have faith in their own skills frequently enjoy studying more. Both can be supported by game-based learning resources such as Minecraft. To precisely grasp how these two elements relate in gamified learning settings, more research is still required.

3. METHODOLOGY

3.1 Research Design

This study used a mixed-methods approach, combining both quantitative and qualitative data. The aim was to identify the relationship between students' self-efficacy and affective engagement in learning mathematics using Minecraft Education Edition as a gamification tool. The quantitative part used surveys to measure students' levels of self-efficacy and affective engagement. For the qualitative part, open-ended questions were used to gather students' feedback and perceptions after the activity.

3.2 Research Instruments

The total population in this study was 296 students and the sample of 169 Form 4 students from SMK USJ 12, Subang Jaya, Selangor participated in this study, where the sample size was determined using Krejcie and Morgan's table. A **structured questionnaire** adapted from [11] was employed which consists of: Section A measured demographic profile, Section B measured self-efficacy with 7 items, and Section C measured affective engagement with 6 items. A 4-point Likert scale was used to score each item, with 1 denoting "strongly disagree" and 4 denoting "strongly agree". Three open-ended questions were utilized in the qualitative section to investigate students' emotions, self-assurance, and enjoyment of using Minecraft to learn mathematics.

3.3 Data Analysis

The data analysis was done using SPSS for quantitative data:

- Descriptive statistics (mean, standard deviation) were used to analyze self-efficacy and affective engagement levels.
- Pearson correlation was used to test the relationship between self-efficacy and affective engagement.

The qualitative responses were analyzed using thematic analysis to identify key themes and insights from students' experiences.

4. RESULTS AND DISCUSSIONS

This study involved 169 Form 4 students, and their responses were analyzed to measure their self-efficacy and affective engagement in learning mathematics using Minecraft Education Edition. The study also explored the relationship between these two variables.

Table 1. Descriptive statistics of students' self-efficacy

Variable	Mean	Standard Deviation
Self-efficacy (N=169)	3.14	0.30

The descriptive statistics of students' self-efficacy in learning mathematics with Minecraft Education Edition are shown in Table 1. The self-efficacy score was moderately high, with a mean of 3.14 and a standard deviation of 0.30. This implies that most students thought they could learn math through the game. The high percentage of agreement with statements like "I am sure that I can learn mathematics through Minecraft" and "I think I could handle more difficult mathematics using Minecraft" indicates that most students felt confident in their mathematical skills when they were in a gamified environment. These results support Bandura's theory that mastery experiences and effective task completion can improve self-efficacy.

Table 2. Descriptive statistics of students' affective engagement

Variable	Mean	Standard Deviation
Affective Engagement (N=169)	3.43	0.26

With a mean score of 3.43 and a standard deviation of 0.26, students also reported high affective engagement, as indicated in Table 2. This implies that students' learning experiences involved emotional engagement. "I feel joyful in learning mathematics through Minecraft" and "Learning mathematics through Minecraft is interesting" were the items with the highest level of agreement. These findings show that students' interest and willingness to learn mathematics rose when they used Minecraft.

A Pearson Correlation analysis was performed to investigate the relationship between students' affective engagement and self-efficacy to assess the third research objective. Table 3 displays the findings with the p-value was 0.168 and the correlation coefficient was $r = 0.106$. This suggests that in this study, there is no statistically significant correlation between these two variables.

Table 3. Pearson correlation between self-efficacy and affective engagement

Variable	r	p-value
Self-efficacy and affective engagement	0.106	0.168

Although both variables were individually high, their relationship not significantly correlate. One possible reason could be different aspects of the gamified learning process have helped students gain emotional involvement and confidence. For example, some students may fine the platform features enjoyable without necessarily feeling more confident in the mathematics skills, or the other way around. These findings contrast with those mentioned in Montoya et al. [3], who reported that these variables were positively correlated in game-based learning. Therefore, further studies are required to determine whether specific elements of gamification affect these psychological factors and how they interact.

5. CONCLUSIONS AND FUTURE RECOMMENDATIONS

This study examined the impact of Minecraft Education Edition, utilized as a gamification tool, on students' self-efficacy and emotional involvement in mathematics learning. The results showed that when using Minecraft, student' levels of affective engagement and self-efficacy were both moderately high. According to these findings, gamified learning can boost students' self-esteem and make learning mathematics more enjoyable. However, there was no significant

correlation between self-efficacy and affective engagement according to the correlation analysis. This indicates that even though students experienced emotional engagement and confidence, these two outcomes did not seem to have a direct impact on one another in this situation. Other outside variables, like past Minecraft experience, learning preferences, or the type of mathematical task, could be to the external factors for these outcomes**.**

The study's overall findings indicate that Minecraft Education Edition offers positive potentials for improving motivation and emotional engagement in mathematics classes. It provides a more participatory and student-focused method that can add interest and significance to abstract subjects.

Future research could further test the interactive hypothesis by using different game-based tools or providing longer exposure to Minecraft to examine whether self-efficacy and affective engagement align over time. Comparative studies involving other educational games or teaching tools are also recommended to identify which platforms most effectively enhance student confidence and engagement. Finally, exploring the long-term effects of gamification on students' academic performance and motivation in mathematics would provide valuable insights into its sustained impact. By continuing to investigate the role of gamification in learning, educators and policymakers can make more informed decisions on how to integrate digital tools effectively into the curriculum

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