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Improving Science performance through games: An Analysis of Game-based Learning in Earth and Life Science

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Abstract

Game-based learning (GBL) has emerged as a promising pedagogical strategy in science education, aiming to enhance student engagement and academic performance. This study investigates the effectiveness of GBL in Earth and Life Science classes among grade 11 students. A quasi-experimental design with pre-test and post-test measurements was employed, comparing a control group with traditional instruction to an experimental group using GBL. Results indicate a significant improvement in students' academic performance in the experimental group compared to the control group. Statistical analysis revealed higher post-test scores in the experimental group, suggesting the efficacy of GBL in enhancing learning outcomes. The study underscores the importance of individualized approaches and innovative methodologies in science education, emphasizing the potential benefits of integrating GBL into the curriculum. Recommendations include integrating GBL methodologies into science curriculum, providing professional development for instructors, fostering collaboration among stakeholders, and assessing long-term effects on student performance and attitudes toward science. Overall, GBL presents a valuable supplement to traditional instructional methods, catering to diverse learning styles and preferences in science education.

Keywords: Game-based learning; Earth and Life Science; Academic performance; Instructional method

1. Introduction

In recent years, educators have explored alternative teaching methods to improve student engagement and academic achievement in science. One such method that has gained attention is game-based learning (GBL), where educational games are used as tools to teach and reinforce scientific concepts. Game-based learning can be effective in improving student's academic performances. The GBL technique, according to Khairuddin and Mailok (2019), is used to encourage and motivate students to engage more fully in the learning process, to make the process more pleasurable, and to help them understand the material more fully. With the use of the GBL technique, teachers may include active learning into their lessons, boost student interest and engagement, and get immediate feedback on their students' performance. Previous study implies that game-based learning has a great effect on students' critical thinking as they need to think faster, for the reasons that game-based learning has a time limit, (Mao, Cui, Chiu, & Lei, 2021).

Educational games provide a dynamic platform for students to interact with scientific knowledge in a fun and engaging way. Students can investigate natural occurrences, carry out virtual experiments, and find solutions to scientific puzzles in a simulated setting by engaging in gamified activities. This interactive approach promotes not only curiosity and critical thinking abilities, but also collaborative learning and problem solving among peers. Additionally, it's one of the more inventive and engaging approaches, and pupils will unintentionally pay attention to the teacher's lessons. This is because pupils are naturally inclined to play games. Furthermore, educational games can help students love learning, feel at ease taking on a range of challenges along the way, and overcome these obstacles with patience, focus, and confidence which are critical for higher education in creating lifelong learners (Liu et al., 2021).

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A potential method to science education is game-based learning, particularly when it comes to introducing and debating difficult subjects and ideas (Al-Tarawneh 2016). However, Zeng, Zhou, Hong, Li, and Xu (2020) pointed out that, even though in recent years, game-based learning has garnered significant interest in the educational field, yet, its use is not really established. A growing number of educators are looking to game-based learning as a promising pedagogical strategy in recognition of the need for creative ways to improve student learning in Earth and Life Science. Through the incorporation of gameplay, interactivity, and storytelling into educational activities, game-based learning provides students with an engaging and dynamic means of investigating scientific phenomena, testing theories, and drawing connections between theoretical knowledge and practical applications.

The purpose of this research is to determine whether game-based learning can help students perform better in Earth and Life Science classes. Students are given a more interesting and practical method of learning complex scientific concepts by incorporating interactive and immersive gaming experiences into the curriculum. By examining the impact of game-based learning on students' understanding and retention of earth and life science concepts, this study aims to provide valuable insights into the potential of educational games as effective learning tools in science education. For educators looking for innovative strategies to support student achievement and interest in STEM subjects, it is important to understand how games can be integrated into the classroom to improve science learning outcomes.

2. Material and methods

The research design utilized in this study was quantitative approach specifically quasi-experimental design with pre-test and post-test measurements to compare the effectiveness of game-based learning in Earth and Life Science. According to Zubair (2023), an experimental study is an objective process and scientific method that involves an investigation to extinguish the influence of the independent variable on the dependent variable and the changes it makes. Zubair (2023) also stated that the quasi-experimental method is more accurate when it comes to results and findings and it forms cause-and-effect relationships that validate or invalidate the hypothesis.

Moreover, this method allows the researcher to collect data through pre-tests and post-tests to identify the effectiveness of game-based learning in terms of student's academic performance. Additionally, the researcher used two different data sets as participants (control group and experimental group) to determine whether there are significant changes in students' academic performance, especially in their Earth and Life Science grades, before and after using game-based learning. With this, the validity and credibility of the findings will be enhanced. The respondents of this study are the grade 11 students of Bahay Pare National High School in Technical-Vocational-Livelihood (TVL) strands taking Earth and Life Science subject who were randomly assigned to either the experimental group (using game-based learning) or the control group (traditional instruction).

In this study, pre-test and post-test crafted by the researcher was used as the research instrument. This instrument can help measure the difference in student's academic performance before and after they use game-based learning. The pre-test will serve as the baseline to compare the post-test results. The test was composed of twenty (20) multiple-choice questions that underwent thorough validation from 4 professionals in the field of science, statistics, research, and education. The study used the following statistical treatments: mean and standard deviation, and T-test. Moreover, The Statistical Package for the Social Sciences (SPSS) was also used to conduct a quantitative analysis of the gathered data ensuring higher reliability and accuracy. These were administered to 55 learners in the control group and 55 learners in the experimental group, both taking Earth and Life Science subject.

Likewise, ethical considerations were strictly observed during the data collection by obtaining informed consent from all the participants, explaining them the purpose, benefits and confidentiality measures ensuring that their identities and responses are kept confidential.

3. Results and discussion

The following were the results of the data gathered from the respondents.

Table 1 presents the mean and standard deviation of students' pre-test and post-test score from the control group. The results show that the students have fairly satisfactory pre-test scores (M =7.36, SD = 2.66, N = 55). On the contrary, their post-test scores are satisfactory (M =7.36, SD = 2.66, N = 55).

Table 1 Mean and Standard Deviation Interpretation for the Control Group Respondents' Scores in Pre-test and Post-Test

Control Group	**Inventory Score**			
	N	M	SD	Interpretation
Pre-test	55	7.36	2.66	Fairly Satisfactory
Post-test	55	9.23	3.04	Satisfactory

Table 2 Mean and Standard Deviation Interpretation for the Experimental Group Respondents' Scores in Pre-test and Post-Test

Experimental Group	**Inventory Score**			
	N	M	SD	Interpretation
Pre-test	55	9.43	2.81	Satisfactory
Post-test	55	15.37	2.04	Very Satisfactory

Table 2 presents the mean and standard deviation of students' pre-test and post-test score from the experimental group. The results show that the students have a satisfactory pre-test score (M = 9.43, SD =2.81, N = 55). Additionally, their post-test scores are very satisfactory (M = 15.37, SD =2.04, N = 55). This indicates that the performance of students in earth and life science improved with the help of game-based learning. Thus, using game-based learning can greatly increase the student's learning outcome compared to traditional learning.

Table 3 Difference between Experimental Group Test Results and Control Group Test Results

Group	**Test Results**		***t***	***df***	***p***
	M	*SD*			
Experimental Group	-5.944	3.033	-14.534	54	0.000
Control Group	-1.873	3.151	-4.408	54	0.000

Table 3 shows the results of a paired samples T-test which was used to determine whether there is a significant difference between the tests of the control group and the experimental group. As shown in the table, when the experimental group (M = -5.944, SD = 3.033) and the control group (M = -1.873, SD = 3.151) were compared, there is a significant difference between the two. The experimental group has the higher results (t (54) = -14.534, p<0.001) than the control group (t (54) = -4.408, p<0.001). As stated by the study of Kaimara, Fokides, Oikonomou and Deliyannis (2021), the findings determined that GBL is a helpful tool that enhances the student's learning outcomes, as they are motivated to participate. It has numerous effects on students' performance. As it trains their brain to think faster, their cognitive skills improve, especially their problem-solving skills. Additionally, Hung, Huang, and Hwang (2014) found that students under digital game-based learning outperform e-learning and traditional learning in terms of academic achievement. Overall, the results conclude that using game-based learning as educational aids proves to be more effective than just simply discussing the lesson through presentation.

4. Conclusion

Based on the results and discussion of the study, the following conclusions were determined: (1) The control group's consistent scores prompted a closer examination of instructional methods. In contrast, the experimental group, with personalized learning interventions, showed significant post-test improvement. This underscores the importance of individualized approaches for enhanced learning outcomes, highlighting the potential benefits of innovative methodologies in Earth and Life Science; (2) Game-based learning significantly impacted students' grades, leading to a higher learning outcome; and (3) Integrating game-based learning into Earth and Life Science can provide a valuable

supplement to traditional instructional methods, catering to diverse learning styles and preferences.

Recommendations

Based on the conclusions drawn from the study, the following recommendations are suggested for educators, curriculum developers, and policymakers:

- To improve student accomplishment in Earth and Life Science, integrate game-based learning methodologies into the science curriculum;
- Provide instructors with professional development opportunities to help them effectively integrate game-based learning tools and resources into their curriculum;
- Encourage collaboration among educators, game developers, and researchers to create and execute high-quality educational games that are suited to Earth and Life Science topics; and
- To further substantiate the efficacy of game-based learning, assess the long-term effects on students' science performance and attitudes toward science.

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