Game-Based Education Using Minecraft in Developing Students Performance and Interest in Basic Landscaping

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Abstract:

This study aimed to delve into the effectiveness of Minecraft as a game-based approach in education in enhancing the performance and interest of thirty-four (34) third year higher education students with no prior knowledge of basic landscaping. Objectives include evaluating the intervention's effectiveness, measuring changes in academic performance and interest. Employing a quasi-experimental design, the Experimental Group (EG) experienced the game-based approach, while the Control Group (CG) received a conventional approach. The data collection process encompassed pre-tests, post-tests, the application of the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the solicitation of feedback from the students. The statistical analyses included calculations of median, mean, standard deviation, percentage distribution, and t-tests. The outcomes of the experiment involving the use of Minecraft reveal its noteworthy positive effects on academic performance. The pretest and posttest scores of students in the experimental group demonstrated substantial improvements in their understanding of the principles of basic landscaping.

Keywords: Minecraft, game-based learning, landscaping, academic performance, student interest, educational technology, quasi-experimental design

1. Introduction

In the ever-changing world of education, technology has changed the way standard lessons are taught, challenging teachers to find new ways to teach that make sense for the way students learn today (Yalçın-İncik and İncik, 2022) . Since Generation Z of learners was born in the digital age, they have their own traits and tastes that set them apart from older generations. As this generation navigates a world full of information and interactive media, it will be challenging for teachers to figure out how to use these new technologies to improve students' learning and results (Szymkowiak et al., 2021).

The Journal on Empowering Teaching Excellence notes that studies have shown that Gen Z students prefer learning through videos and images as opposed to traditional text-heavy resources (Mohr & Mohr, 2017). This is why it's becoming more and more important to find a way to connect conventional methods of instruction with what modern students would like. Using technology in the classroom has worked before, but exploring another approach such as game-based learning is a very interesting way to get students interested, creative, improve students' academic performance and help them learn new skills. Using what

James Paul Gee (2003) said as a starting point, a strong case is made for the complex link between learners playing video games and learning. Gee says that novel literacy gained through games not only helps students get better at skills, but it also gives them a sense of agency and control, which are all qualities that easily transfer to meeting larger educational goals. Gee's claim emphasizes the transformative potential of games as an educational tool and provides a basis for studying how this relationship can be used to improve learning outcomes in a variety of educational settings.

The main objective of this study is to develop a Minecraft virtual environment for learning and investigate the impact of integrating game-based education, particularly leveraging the immersive virtual environment of Minecraft, on the academic performance, interest, and practical skill acquisition of Generation Z students in the context of basic landscaping. Through a quasi-experimental research design, the study aims to compare the outcomes of a group exposed to game-based learning with those undergoing conventional approach. By assessing academic performance, interest, and the practical application of acquired skills, the research seeks to provide valuable insights into the effectiveness of game-based learning in enhancing the educational experience for modern learners in the field of basic landscaping.

This research aligned with the United Nations' Sustainable Development Goals (Global Goals; UN, 2015) by helping develop important skills for the future, as outlined in the OECD 2030 Learning Compass framework (OECD, 2019).

This framework is a comprehensive model that emphasizes key skills for the 21st century. It focuses on competencies like critical thinking, problem-solving, collaboration, and creativity, which are essential in modern education. Using Minecraft as a tool for game-based education to develop students' performance and interest in basic landscaping, this study aligns with the OECD framework.

Minecraft, as an educational platform, serves as a comprehensive theoretical framework fostering through landscape construction challenges, collaborative teamwork, innovative design opportunities, and digital tool utilization within its open-ended digital environment

Statement of the Problem

The lack of experience and limited use of technology in teaching landscaping subjects may lead to reduced student interest and performance in the subject. To address this issue, Minecraft may be a relevant and effective tool for enhancing students' performance and interest in landscaping education. It will also address the primary problem of the demand for resources and space available for students to practice and freely express their design creativity. The high cost and technical requirements of conventional landscaping tools compound this limitation. Using Minecraft, students can learn principles of basic landscaping virtually without physical space limitations, safe and controlled environment, virtual hands-on experience and high cost equipment. The research will investigate how much Minecraft can support effective learning outcomes in learning the topic of principles in basic landscaping. Specifically, it will focus on how this tool develops students' performance and interest in the subject. The findings of this research will provide insights into the potential benefits of incorporating Minecraft into the curriculum as a tool for teaching basic landscaping.

Research Objectives

This study investigates how Minecraft influences students' academic performance and interest in basic landscaping.

1. Design an activity in principles of basic landscaping using the Minecraft platform.
2. Develop Minecraft game-based activity.
3. Test and implement Minecraft to students.
4. Evaluate students' significant difference in pre-test and post-test score.
5. Compare EG and CG output scores.

2. Literature Review

The Benefits and Advantages of Learning Basic Landscaping

Learning basic landscaping is essential for individuals interested in pursuing a career in landscape design, horticulture, or agriculture. It is also essential for homeowners who want to create and maintain their outdoor spaces. According to the American Society of Landscape Architects (ASLA), landscaping can provide numerous benefits, including improving the quality of life, reducing stress levels, increasing property value and improving environmental sustainability (ASLA, 2023). Studies have shown that exposure to nature and green spaces can positively impact mental health and well-being. In a study by the University of Exeter, researchers found that individuals who spent time in nature had lower stress levels and were likely to report good health (White et al., 2019). Learning basic landscaping can also promote environmental sustainability by teaching individuals about water conservation, natural resource management and the use of native plants.

Furthermore, learning basic landscaping can also improve job opportunities in the green industry. According to the Bureau of Labor Statistics, employment of landscape architects and designers is projected to grow 6 percent from 2019 to 2029, faster than the average for all occupations (BLS, 2020).

Minecraft

Minecraft is a sandbox video game that was first released in 2011. The game allows players to explore, build and interact with a block-based 3D world. Players can gather resources, craft tools and items and create structures and objects of their own design (Mojang Studios, 2021). Minecraft can both be played on mobile devices and supported operating systems on the computer.

Minecraft Education is a modified version of Minecraft specifically designed for educational settings (Dikkers, 2018). It allows teachers to create customized learning activities and scenarios and provides students with an immersive and engaging learning environment. Minecraft Education includes various useful features and tools for basic landscaping and civil works, including building structures, modifying terrain and using tools and materials to create and manipulate objects.

Although there are many potential benefits to using ME for basic landscaping and civil works, it is essential to consider particular challenges. One of the main challenges is the need for specialized hardware and software. In order to use ME effectively, students and teachers need access to computers or tablets with sufficient processing power and hardware requirements (Petrov, 2014). They also need access to the ME software, which may require additional licenses or subscriptions. Additionally, Anton Petrov (2014)

added that another challenge of using Minecraft Education is the need for teacher training and support. The training of teachers is necessary for effectively using Minecraft Education in the classroom, along with providing them access to resources and support to aid in developing lesson plans and activities that align with the curriculum. Without proper training and support, the use of Minecraft Education in basic landscaping and civil works may not be as effective as it is (Dikkers, 2018).

In this study, the researcher, who is not only an avid player of computer games, especially Minecraft, but also serves as the developer of the learning environment. This unique combination of gaming enthusiasm and content creation underscores the researcher's expertise and hands-on involvement in crafting a tailored and engaging learning experience for the students.

Minecraft and Critical Thinking
According to a study by Cheng et al. (2019) minecraft has also been shown to promote critical thinking skills among students. Through its gameplay, Minecraft encourages students to think strategically and make decisions that can affect the game's outcome.

Minecraft and Creativity
Minecraft is designed to provide students with an immersive and creative learning experience. According to the study of Fauzan et al. (2018), the impact of Minecraft video games on creativity. The research focused on monitoring brainwave activity while participants engaged in Minecraft gameplay and other video games. The findings from this investigation indicated that the average brainwave activity across various sub-bands was notably higher during Minecraft gameplay compared to other video games. Specifically, the prevalence of delta waves at Fp1 and Fp2 suggested heightened attention levels and improved decision-making abilities among the subjects.

Furthermore, elevated alpha waves at T3 and T4 during Minecraft gameplay implied the simultaneous activation of both brain hemispheres. These outcomes emphasized Minecraft's potential to enhance high-level cognitive processes. The primary cognitive mechanism observed during Minecraft gameplay was closely associated with the fronto-parietal attentional control network, including sub-networks such as the executive control network, default mode network, and salient network, as previously identified in related research (Fauzan et al., A. J. A., 2018).

Other Benefits of Minecraft
Minecraft, a popular open-world computer game, has gained attention in education due to its potential for enhancing learning and social interaction. Research shows that game-based learning, including Minecraft, can be an engaging way to educate (Alawajee & Delafield-Butt, 2021). The study of Omar Alawajee and Jonathan Delafield-Butt, reviews existing research to explore the role of Minecraft in education and psychological interventions. The findings from 42 papers suggest that Minecraft can boost motivation, language skills, and academic learning, especially in subjects like science and history. It also helps students develop essential social skills such as communication, sharing, collaboration, and leadership. Although concerns about age-appropriateness, safety, technology usage, and learning outcomes have been raised, the overall evidence supports the informed and guided use of Minecraft to enhance learning and

engagement in educational settings. Minecraft has also been found to be an effective tool for teaching computer programming concepts (Dikkers, 2018).

Blocks in Minecraft

The Minecraft world is composed of one-meter cubic blocks, systematically generated to form expansive landscapes that span a variety of biomes (Kørhsen et.al, 2015) In Minecraft, blocks are essential construction materials that allow players to create various structures. These items are integral to all game versions and can be crafted by the player or found naturally in different biomes. Additionally, certain blocks are only available in Creative Mode, providing players with even more options for their creations. The creative possibilities are boundless as students utilize these blocks to construct intricate buildings, shape landscapes, and embark on imaginative projects. The transformative nature of the game allows players to convert these blocks into diverse materials or tools, providing a dynamic and engaging experience that seamlessly combines creativity with exploration.

3. Methodology

In this section, the research methodology was outlined, providing details about the Research Design, Research Variables, Research Instruments Used, Data Gathering Procedures, and Data Analysis. This section aimed to clearly describe how the researcher conducted the study and analyzed the data.

Research Design

In this study, a mixed-method research design incorporating both quantitative and qualitative methodologies was employed, utilizing a quasi-experimental research design. According to Creswell (2014), a quasi-experimental research design involves comparing groups or conditions that differ on the independent variable, which, in this study, happened to be the use of Minecraft as a teaching tool. The dependent variable was the students' interest and performance in basic landscaping, such as their understanding of basic landscaping principles.

To implement a quasi-experimental research design in this study, two groups of students were formed. The Experimental Group received instruction using Minecraft as an intervention, while the Control group (CG) received conventional instruction without the intervention. The learning outcomes of the two groups were then compared to determine the effectiveness of using Minecraft as a tool in teaching principles in basic landscaping.

To ensure a standardized evaluation of the effectiveness of the intervention, both the EG and CG utilized SketchUp, a free software provided by the institution through their institute accounts, as a common software tool. SketchUp was chosen for its suitability in assessing the final output of basic landscaping designs (Galani, 2016), providing a comparable benchmark of learning outcomes across both groups.

Research Participants

This study employs a quasi-experimental design with a total participant of thirty-four (34) third-year higher education students, who had not yet taken the basic landscaping course as part of their curriculum, were included in the study. The participant pool consists of both high-achieving and low-achieving

learners to ensure a diverse representation. The class was divided into two groups comprising 17 students each for both EG and CG.

The participants were chosen specifically because the basic landscaping subject is a part of their curriculum that they had not yet undertaken. This deliberate selection provides an opportunity to assess the impact of the intervention on students who are approaching the subject with varying levels of prior knowledge and experience. Both the CG and EG groups underwent a pretest to establish baseline performance levels. The pretest and post-test consisted of multiple-choice questions designed to evaluate participants' comprehension. Consent form was given to ask the respondents willingness to participate.

Research Instruments

To comprehensively understand the participants and assess the educational intervention's effectiveness, the researcher utilized a range of research instruments. This included validated researcher-designed questionnaires and a rubric to evaluate students' practical application of basic landscaping principles in their output performance.

To look into participants' perceptions and acceptance of technology, the study leveraged the Technology Acceptance Model (TAM) proposed by Davis (1989). This model, which has been extensively validated, allowed for an exploration of how participants embraced technology, specifically in the context of using Minecraft. In tandem with TAM, the Unified Theory of Acceptance and Use of Technology (UTAUT) model by Venkatesh (2003) was employed. This model provides a comprehensive framework to predict user acceptance of technology by considering various factors, such as Behavioral Intention to Use and User Willingness.

Ensuring the educational soundness of the intervention was crucial, and to achieve this, an expert evaluation was conducted. Criteria from the Department of Education's Learning Resource Management and Development System (LRMDS) Educational Soundness General Evaluation Checklist were utilized in this evaluation (DepEd, 2009).

The evaluation of students' output was conducted by experts in the field. These experts assessed the outcomes of the educational intervention based on established criteria using the developed Rubric, providing valuable perspectives on the effectiveness of using Minecraft for teaching basic landscaping.

4. Results and Discussions

This chapter presents and discusses the data analysis and findings of the results based on the order of the objectives of the study. These are the quantitative and qualitative data gathered throughout the whole duration of the study using the research instruments. It also describes the effectiveness of Minecraft as learning material in the respondents' interest and performance in basic landscaping.

Table 1. Significant difference between pre-test and post-test scores of EG and CG | n=34

Type of Data	Type of Test	t-statistics (pvalue)

	Pre-test	SD	Post-test	SD	
Experimental Group (EG)	25.765	8.243	31.588	7.027	3.412* (0.002)
Conventional Group (CG)	23.588	9.267	32.118	6.030	5.508* (0.000)

The t-statistics value of 3.412 and p-value of 0.002 (p<0.05) in Table 1 shows that there is a significant difference between the pre-test and post-test scores of students using Minecraft.

To support this finding, the study by Tangkui and Keong (2023) examined the impact of using Minecraft as an educational tool for teaching fractions. Their research revealed that students in the treatment group exposed to Minecraft achieved higher scores in fraction problem-solving. Minecraft can effectively enhance learners' higher-order thinking skills, particularly in evaluation. The findings support the idea that incorporating Minecraft into education can improve students' ability to think critically and solve complex problems (Tangkui & Keong, 2023). The study of Al-Haqbani (2022) found a significant difference between pretest and posttest scores of the vocabulary test, indicating that implementing Minecraft was an effective tool in enhancing vocabulary learning.

Likewise for CG, the t-statistics value of 5.508 and p-value of 0.000 (p<0.05) in Table 1 shows that there is a significant difference between the pre-test and post-test scores of students using the conventional method data. In education, traditional or conventional teaching methods often refer to time-tested approaches to instruction, such as lectures, textbooks, and in-person classes. These methods have been used for generations and are still prevalent in many educational systems worldwide (Papert, 1993). The conventional method exhibits a significant difference in student outcomes, and this variance may be attributed to teacher-related factors or students' intrinsic interest in the subject matter.

The data strongly suggests that both the EG and CG led to improvements in the test scores of the respective groups. However, the conventional method appears to have elicited a more pronounced increase in scores compared to the experimental method. The statistical significance of the results underscores the effectiveness of both teaching approaches in enhancing student performance, albeit with varying degrees of impact.

Table 2. Descriptive statistics of the respondents' perceptions regarding the perceived usefulness, perceived ease of ese, behavior intention to use and users' willingness to use Minecraft | n=17

Technology Acceptance Model (TAM)	Median (overall)	Variance (overall)	SD (overall)	Interpretation
Perceived Usefulness	4.50	0.53	0.73	Strongly Agree
Perceived Ease of Use	4.17	0.61	0.77	Agree

Unified Theory of Acceptance and Use of Technology (UTAUT)	Median (overall)	Variance (overall	SD (overall)	Remark
Behavioral Intention to Use	4.25	0.66	0.80	Strongly Agree
Users Willingness	4.33	0.73	0.84	Strongly Agree

Note: 1.00-1.80 = Strongly Disagree; 1.81 – 2.60 = Disagree; 2.61- 3.40 = Neutral; 3.41 – 4.20 = Agree; 4.21 – 5.00 = Strongly Agree

The overall median score of 4.50 as shown in Table 2 describes that respondents have a very positive perception with regards to the perceived usefulness of Minecraft. Utilizing Minecraft for learning offers students a holistic and practical educational experience that has been positively useful (Slattery et al., 2023). In addition, the overall standard deviation shows that, on average, the difference between the mean and individual data points is 0.73 (<1.00). This indicates a low variability of data points. In terms of perceived ease of use as shown in Table 2, which is 4.17, indicates that respondents have a positive perception of Minecraft. The overall standard deviation of 0.77 (<1.00) shows a low variability of data points. the platform's user-friendly interface and the positive experiences reported by students reinforce its value as an accessible and enjoyable tool for learning (Slattery el al., 2023).

With regards to the respondents' perceptions about their behavioral intention to use Minecraft, the descriptive statistics results in Table 1 show that most of the respondents strongly agree that they would recommend using Minecraft. They mostly agree that they plan to use Minecraft and have an intention to use it in the future. Moreover, the overall median score of 4.25 shows that respondents have a positive behavioral intention toward using Minecraft. The overall standard deviation of 0.80 (<1.00) shows a low variability of responses. In summary, Minecraft prioritizes student behavioral engagement over standardized scores, emphasizes problem-solving over seeking 'correct' answers, and evaluates their utilization of Minecraft primarily through their own professional development rather than external recommendations (Dikkers, 2018).

The study of descriptive data about how respondents felt about user willingness in the context of Minecraft gives us useful information about how students are receptive and how they feel about this educational approach. It can be seen in Table 2 that the majority of the respondents strongly agree that they have plans to use Minecraft with a colleague. Alawajee and Delafield-Butt (2021) highlight the social interactivity of Minecraft, with its cooperative, open-world gameplay, suggesting its potential value for educational applications. They mostly agree that they will use Minecraft because it's accessible and suitable for their needs, as well as user-friendly. The overall median score of 4.33 shows that the respondents have a very positive perception of their willingness to use Minecraft. The overall standard deviation of 0.84 (<1.00) indicates low variability in responses.

Figure 1.

Comparison of Mean Score on each output criteria between experimental and conventional groups using Rubric.
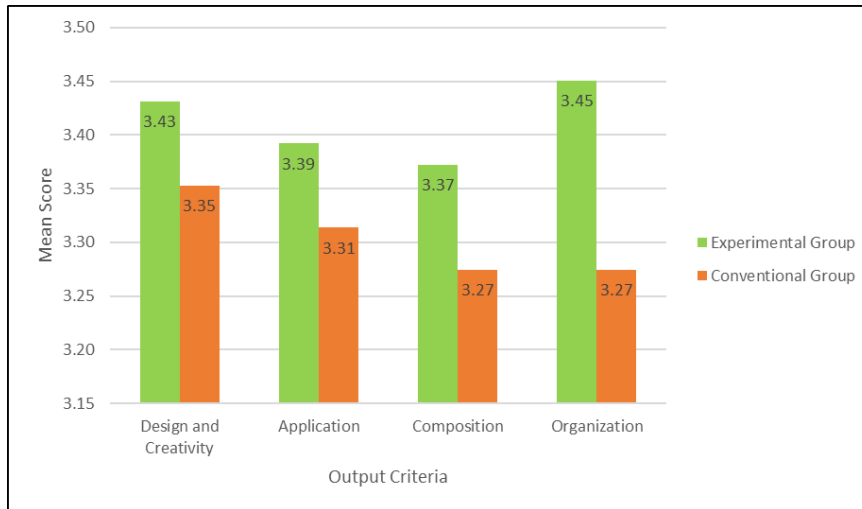
Note: 1.00-1.99= Poor; 2.00 – 2.99 = Fair; 3.00- 3.99 = Good; 4.00 = Excellent

Rubric was used as inspired by the research of Dasgupta et al. (2014), they developed a rubric for experimental design to assess the knowledge of students and diagnose their difficulties. The results highlighted students' challenges with various variables and experimental controls, and the rubric was used to compare the scores of the experimental and control group students. As shown in Figure 1, the experimental group obtained a higher mean score for each output criteria than the conventional group. In terms of the design and creativity criteria, the experimental group has a higher mean score than the conventional group by 0.08 points. Likewise, in application criteria, the experimental group has a higher mean score than the conventional group by 0.08 points. In terms of composition, the experimental group still has a higher mean score than the conventional group by 0.10 points. Moreover, in terms of organization criteria, the experimental group has a higher mean score than the conventional group, with a difference of 0.18 points. This indicates that the students in the EG are performing better in terms of their output in basic landscaping plan than the students in the CG.

Qualitative feedbacks of the respondents with regards to Minecraft for learning principles in basic landscaping

This section will showcase the qualitative feedback from seventeen (17) respondents, highlighting their feedback regarding the effectiveness of Minecraft in learning principles in basic landscaping. It includes the advantages and opportunities including challenges that students face while using Minecraft as a game-based education tool.

The thematic analysis of participant responses revealed a resounding sentiment regarding the enjoyment and perceived amusement associated with the utilization of the game-based using Minecraft. A significant 43% of respondents explicitly expressed their positive perception of the platform's fun and enjoyable aspects. Among the gathered responses, the consensus echoes a positive interest toward the platform, encapsulated by phrases such as "enjoyable," "interesting," and "fun."

One participant articulated their experience by expressing, "I find it enjoyable and effective for learning about landscaping and environmental design. It allows for hands-on, creative learning experiences in a virtual world." This statement not only highlights the enjoyment factor but also underscores the platform's efficacy in fostering a hands-on and creative educational environment. Similarly, another participant succinctly remarked, "It is interesting and enjoyable." This concise yet impactful statement reinforces the overall positive perception of the tool's usability, emphasizing the blend of both fascination and pleasure experienced while engaging with the learning interface. Moreover, an initial impression shared by a respondent was, "My initial thought is that it will be fun while learning." This statement underscores the anticipatory excitement associated with the platform, implying an expectation of enjoyment intertwined with the learning process. Through the use of Minecraft, participants reported finding enjoyment in the activities and noted an enhancement in their academic performance due to the collaborative tasks required for completion (Swier, 2014).

An overwhelming 36% of respondents specifically praised Minecraft for enabling a hands-on learning environment. One respondent pointed out, "Compared to conventional methods, Minecraft lets its users experience real-time designing of planned landscapes, making it easier to control and continuously create what the mind imagines." This feedback underscores the platform's unique ability to provide real-time, hands-on experiences in landscape design, aligning with the perception of 36% of respondents.

A notable 14% of respondents specifically acknowledged the contribution of NPCs in simulating interactions relevant to landscaping. One respondent noted, "NPCs help me simulate interactions related to landscaping, like virtual guides providing tips or quests related to landscaping projects, enhancing the learning experience." This feedback emphasizes the pivotal role of NPCs as virtual guides, offering valuable tips and quests that enrich the learning journey within Minecraft. Furthermore, another respondent expressed enthusiasm for conversing with computer characters within the game, stating, "Yes, talking to computer characters in the game is cool. It feels like we're working with a client who wants a specific type of landscape. This makes learning more interesting." This sentiment underscores the immersive nature of these interactions, likening them to real-world scenarios and enhancing the overall appeal and engagement of the learning process. The study of Steinkuehler and Duncan (2008); Gee (2003) highlights the role of NPCs in offering guidance and support, which can be invaluable for learners in acquiring and applying knowledge.

While the feedback predominantly highlighted positive experiences, a minority of respondents, accounting for 14%, acknowledged certain challenges, particularly pertaining to physical health issues when using Minecraft for extended periods. Two respondents specifically highlighted concerns about potential health impacts, primarily eye strain, resulting from prolonged computer usage. One respondent stated, "But the disadvantage is, it can affect our health because staying long hours in front of a computer can cause eyestrain and other health issues." This sentiment emphasizes the potential risks associated with prolonged screen time during educational activities. Moreover, another respondent suggested the incorporation of rest intervals to mitigate health problems arising from prolonged computer usage, stating, "...should give us some rest time so that we don't have any problem with our health." These responses, while constituting a minority (14%), underscore the importance of acknowledging and addressing potential physical health issues, such as eye strain, associated with extended use of educational platforms like Minecraft.

Implementing strategies like scheduled rest breaks could potentially mitigate these concerns, ensuring a healthier and more balanced learning experience. This aligns with the importance of ergonomic considerations and user comfort in digital learning environments (Tawil et al., 2018).

5. CONCLUSIONS

The usefulness of Minecraft as a game-based learning resource for higher education students was examined in this study. The results offer important new information about how student academic performance is affected by Minecraft along with their interest. The outcomes for the experimental group demonstrate how beneficial Minecraft is for academic achievement. The pre-test and post-test scores of the students in this group showed significant changes, indicating that they had made significant progress in basic landscaping. Additionally, they demonstrated a strong desire to use Minecraft in their upcoming educational activities, highlighting the platform's potential to improve student performance and interest.

On the other hand, the control group likewise performed well, showing significance in both the pretest and posttest scores. In terms of output criteria, the group's mean score was excellent, albeit little lower than that of the experimental group.

In conclusion, Minecraft exhibits the potential for enhancing academic performance and interest of the students with the particular subject, particularly in the context of learning principles of basic landscaping. Students' overwhelmingly positive perceptions of its usefulness and ease of use, along with their behavioral intention to use the platform, indicate a strong preference for incorporating Minecraft into educational practices. Nevertheless, the study has highlighted areas for improvement in usability and user experience. The findings provide valuable insights and recommendations for enhancing Minecraft's role in education, emphasizing its potential as a tool for academic excellence in basic landscaping.

6. RECOMMENDATIONS

Based on the study's findings, future researchers should explore Minecraft's potential across diverse educational settings and subjects, delving deeper into its impact on various disciplines and age groups. Utilizing Minecraft in education presents an opportunity aligned with the OECD 2030 framework. This study's findings should spark broader OECD discussions on integrating game-based learning aligning it with specific learning goals for maximum educational benefit. Improving user experience through interface refinement, clearer guidance, addressing the challenges and enhanced user-friendliness are keys for future advancements.

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