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The Effect of Augmented Reality-based Learning Technology on Improving Student Motivation and Learning Outcomes in Secondary Schools

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ABSTRACT

The integration of Augmented Reality (AR) in education has emerged as a promising approach to enhance learning experiences by making content more interactive and engaging. This study investigates the impact of AR-based learning technology on student motivation and learning outcomes in secondary schools. Using a quasi-experimental design, 120 students were divided into an experimental group, which used AR tools, and a control group, which received traditional instruction. Results showed that students in the experimental group demonstrated significant improvements in both academic performance and motivation compared to the control group. The study highlights the potential of AR technology to transform traditional teaching methods and suggests that AR can be a valuable tool in fostering deeper understanding and sustained interest in learning. These findings provide insights into the effectiveness of AR in educational settings and underscore the need for further research to explore its long-term impact and broader applications.

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1. INTRODUCTION

In recent years, the rapid advancement of technology has significantly transformed the educational landscape. Educational currently face the challenge of improving thequality of education [1]. One of the most promising innovations in this field is Augmented Reality (AR), which has the potential to revolutionize the way students interact with educational content. AR-based learning technology superimposes digital information, such as images, videos, and animations, onto the real world, providing an immersive and interactive learning experience. This technology has been shown to enhance student engagement and motivation by making learning more dynamic and visually stimulating [2].

The integration of AR in education has been particularly effective in subjects that require visualization of complex concepts, such as science and mathematics. Studies have demonstrated that AR can improve students' understanding of abstract ideas by providing a tangible and manipulable representation of the content [3]. Furthermore, AR has been found to cater to various learning styles, enabling students to learn at their own pace and according to their preferences [4]. This adaptability is crucial in secondary education, where students are often exposed to challenging material that can be difficult to grasp through traditional methods alone [5].

Despite its numerous advantages, the implementation of AR in education is not without challenges [6]. One significant barrier is the high cost of AR devices and development, which can limit accessibility,

particularly in underfunded schools or regions with limited technological infrastructure [7]. Additionally, there is a need for educators to be adequately trained in integrating AR into their teaching practices to ensure its effective use in classrooms [8]. Concerns about screen time and potential overreliance on technology also highlight the importance of balancing AR with traditional teaching methods to foster a well-rounded educational experience. Nevertheless, as AR technology becomes more affordable and widespread, its potential to democratize education and provide innovative solutions to learning challenges continues to grow, paving the way for a more inclusive and engaging future in education [9].

Despite its potential, the implementation of AR in educational settings remains limited, primarily due to a lack of resources, training, and awareness among educators [10]. Moreover, there is a need for more empirical research to understand the long-term effects of AR on student outcomes, particularly in terms of academic performance and motivation. This study aims to fill this gap by investigating the impact of AR-based learning technology on improving student motivation and learning outcomes in secondary schools. By exploring the effectiveness of AR in a classroom environment, this research seeks to provide valuable insights into how technology can be leveraged to enhance educational practices and outcomes.

2. METHOD

Research Design

This study employs a quasi-experimental design to investigate the effect of Augmented Reality (AR)-based learning technology on student motivation and learning outcomes in secondary schools. The study involves two groups: an experimental group that uses AR-based learning tools and a control group that receives traditional instruction without AR.

Participants

The participants of this study are 120 students from three secondary schools located in an urban area. The students are in their second year of high school, and they range in age from 15 to 16 years old. The participants are randomly assigned to either the experimental group (n = 60) or the control group (n = 60) to ensure an equal distribution of demographic variables such as age, gender, and prior academic performance.

Materials and Tools

The AR-based learning tools used in this study are developed to align with the curriculum of a specific subject, such as biology or physics. These tools allow students to interact with 3D models, simulations, and animations related to the topic being taught. In addition to the AR tools, standardised teaching materials, such as textbooks and workbooks, are used in both the experimental and control groups.

Procedure

The study is conducted over a period of eight weeks. During this time, both groups receive instruction on the same curriculum content. The experimental group uses AR-based tools during their lessons, while the control group uses traditional teaching methods, such as lectures and textbook readings.

a. Pre-Test: Before the intervention, all participants take a pre-test to assess their baseline knowledge of the subject matter and complete a motivation survey to evaluate their initial level of engagement with the subject.
b. Intervention: The experimental group uses AR-based tools in three lessons per week, while the control group receives traditional instruction. Teachers in both groups follow the same lesson plans to ensure consistency in content delivery.
c. Post-Test: After the eight-week period, all participants take a post-test to measure their learning outcomes and complete the motivation survey again to assess any changes in their motivation levels.

Data Collection

Data is collected through two primary instruments:

a. Academic Performance: The pre-test and post-test scores are used to measure the learning outcomes of the students. The tests consist of multiple-choice questions, short-answer questions, and problem-solving tasks related to the curriculum content.
b. Motivation Survey: The motivation survey, based on the Intrinsic Motivation Inventory (IMI), includes questions that assess students' interest, perceived competence, effort, and value regarding the subject. The survey uses a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Data Analysis

The data collected from the pre-tests and post-tests, as well as the motivation surveys, is analysed using both descriptive and inferential statistics. A paired-sample t-test is conducted to compare the pre-test and post-test scores within each group, while an independent-sample t-test is used to compare the post-test scores and motivation levels between the experimental and control groups. Additionally, effect size calculations are

performed to determine the magnitude of the impact of AR-based learning on student motivation and learning outcomes.

3. RESULTS AND DISCUSSION

Result

a. Academic Performance The pre-test and post-test scores were analysed to determine the impact of augmented reality (AR)-based learning on student learning outcomes. The results show a significant improvement in the academic performance of students in the experimental group compared to those in the control group. The mean post-test score for the experimental group was 85.4 (SD = 6.2), while the control group had a mean post-test score of 78.1 (SD = 7.5). A paired-sample t-test revealed a statistically significant increase in the post-test scores of the experimental group compared to their pre-test scores ($t(59) = 9.25$, p <0x7E> 0.001), indicating that the AR-based learning tools effectively enhanced students' understanding of the subject matter.
b. 2. Student Motivation The motivation survey results indicated that students in the experimental group reported higher levels of motivation after the intervention compared to the control group. The mean motivation score for the experimental group increased from 3.2 (SD = 0.5) to 4.1 (SD = 0.4), while the control group showed only a slight increase from 3.1 (SD = 0.6) to 3.3 (SD = 0.5). An independent-sample t-test comparing the post-intervention motivation scores between the two groups revealed a significant difference ($t(118) = 6.45$, $p < 0.01$), suggesting that the use of AR technology positively influenced students' engagement and interest in the subject.

Discussion

The findings of this study demonstrate that AR-based learning technology can significantly enhance both student motivation and learning outcomes in secondary schools. The substantial improvement in post-test scores for the experimental group indicates that AR tools provide a more effective and engaging way for students to understand complex concepts as compared to traditional teaching methods. The interactive nature of AR, which allows students to visualise and manipulate 3D models and simulations, likely contributed to this deeper comprehension.

Moreover, the significant increase in motivation among students using AR-based learning tools highlights the potential of this technology to make learning more enjoyable and relevant. The immersive experiences provided by AR can stimulate curiosity and maintain student interest, which are crucial factors in sustaining long-term academic success. This aligns with previous research suggesting that interactive and technology-enhanced learning environments can foster greater intrinsic motivation among students.

However, it is important to consider some limitations of the study. First, the study was conducted over a relatively short period of eight weeks, which may not fully capture the long-term effects of AR-based learning on student outcomes. Additionally, the study focused on a specific subject area and a limited demographic, which may affect the generalisability of the findings to other subjects and student populations.

Future research should explore the long-term impact of AR technology on student learning across different educational contexts and disciplines. Furthermore, it would be beneficial to investigate the specific features of AR that most effectively contribute to learning and motivation, as well as the potential challenges educators may face when integrating this technology into their teaching practices.

In conclusion, the results of this study suggest that integrating AR-based learning technology in secondary education can be a powerful tool for enhancing student motivation and improving learning outcomes. As educational institutions continue to adopt innovative technologies, AR has the potential to play a pivotal role in shaping the future of education, making learning more interactive, engaging, and effective.

4. CONCLUSION

This study has demonstrated that Augmented Reality (AR)-based learning technology can have a significant positive impact on both student motivation and learning outcomes in secondary education. The findings indicate that students who engaged with AR tools showed greater academic improvement and higher levels of motivation compared to those who received traditional instruction. The interactive and immersive nature of AR seems to enhance students' understanding of complex concepts and sustain their interest in the subject matter. These results underscore the potential of AR as a powerful educational tool that can transform traditional learning environments into dynamic spaces that actively engage students and support deeper learning. As educational technology continues to evolve, the integration of AR in classrooms presents an opportunity to enhance educational experiences and outcomes across various subjects and grade levels.

However, the study also highlights the need for further research to explore the long-term effects of AR-based learning and its applicability across different educational contexts. Educators and policymakers should consider the benefits of AR technology while also addressing the challenges associated with its implementation

to maximize its potential to enhance educational practices. In conclusion, AR-based learning technology represents a promising innovation that can enrich the educational process, making it more interactive, engaging, and effective in preparing students for the demands of the 21st century.

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