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Relationship Between Immersive Learning and Proficiency Level in Machine Operations Among Technology Education Students in Higher Institutions in Anambra State

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Abstract: This study examined the relationship between immersive learning and proficiency level in machine operations among technology education students in higher institutions in Anambra State. This study adopted a correlational survey research design. The population of the study consisted of 253 Mechanical Technology Education Students in Anambra State. A sample size of 155 students using simple random sampling technique was obtained. The instrument for data collection was a structured questionnaire. The questionnaire was validated by three experts with the reliability Coefficients of 0.71 and 0.81 respectively, established using Cronbach alpha's method. Data collected were analyzed using inferential statistics. Specifically, the Pearson Product-Moment Correlation Coefficient was employed to answer the two research questions. The findings of the study revealed a moderate positive relationship (r = 0.395) between the use of Virtual Reality (VR) simulations and proficiency in machine operations and a strong positive relationship (r = 0.656) between the use of Augmented Reality (AR) tools and proficiency in machine operations among Technology Education students. Based on the findings, it was recommended that universities should integrate both VR and AR tools into Technology Education curricula, with particular emphasis on AR due to its stronger influence on proficiency in machine operations.

Keywords: Immersive learning, augmented reality, virtual reality, proficiency, machine operations

INTRODUCTION

The rapid advancement of technology in the 21st century has transformed the way teaching and learning processes are carried out in technical and vocational education. In particular, immersive learning technologies have emerged as powerful tools that create interactive, engaging, and highly effective learning environments. Immersive Learning (IL) is an educational approach that places learners in an interactive, digitally simulated environment designed to mimic real-life situations, allowing for active participation and skill acquisition. Radianti, Majchrzak, Fromm, & Wohlgenannt (2020) described immersive learning as the use of technologies such as Virtual Reality (VR) and Augmented Reality (AR) to create environments that allow learners to experience and manipulate concepts in realistic settings. Immersive learning allows the simulation of the real world via the virtual world thereby allowing users to perceive virtual components as part of their immediate environment.

Virtual reality has emerged as a powerful educational tool that enhances students' engagement and motivation. According to Jensen & Konradsen, (2019), Virtual Reality (VR) is a computer-generated simulation of a three-dimensional environment that users interact with through headsets and controllers, creating a sense of presence in a completely artificial space. In contrast, Augmented Reality (AR) overlays digital information—such as images, audio, or text—onto real-world settings in real time, enhancing learners' interaction with physical objects (Gopalan et al., 2022). AR consists of interfaces

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that allow interaction between users and digital content, such as 3D objects, superimposing them in real time on the physical environment that surrounds the user. Augmented reality works through the deployment of camera-equipped hardware such as smart glasses or heads-up displays. Mobile devices like iPads or iPhones, which are already built with technologies such as GPS, accelerometers, gyroscopes, and sensors, are particularly compatible with augmented reality applications and can make the technology more accessible to the average consumer.

In machine operations, immersive learning provides hands-on engagement with complex equipment and systems in risk-free environments. Studying immersive learning is not out of place since universities around the globe are now utilizing augmented or virtual reality in some capacity (UKAuthority 2019). Immersive learning aims to make the educational process interesting and motivating through high levels of interactivity, helping students understand complex and abstract concepts more effectively (Fayzullojonovna, 2025). One of IL's most important contributions to education is that it allow students to repeatedly practice complex and demanding tasks in a safe environment. This is particularly true of procedural tasks such as surgical operations or dental procedures that cannot be carried out for real until a certain level of competency has been achieved (Alaraj et al. 2011). It also made an important contribution to education in that it has allowed for students to directly experience environments or situations that are difficult to replicate by using traditional teaching methods such as lectures, slideshows, or 2D videos. Additionally, VR has allowed for students to gain cognitive skills by way of experiential learning, such as exposing them to environments that would be too logistically problematic to visit in reality (Çalişkan, 2011).

Machine operations proficiency refers to the ability of learners to demonstrate mastery in handling, controlling, and maintaining industrial machines with precision, safety, and efficiency. It involves not only technical know-how but also practical dexterity, problem-solving ability, and adherence to industry standards (Li, 2022). Machine operation proficiency has to do with error reduction, accuracy of operations, completion time, and compliance with safety protocols.

Immersive learning allows students to manipulate virtual machinery in realistic settings, which is essential for specialized technology education, ensuring students can operate equipment in environments where actual machinery may be scarce.The main benefits lie in its ability to transform traditional workshop experience into a more interractive and enganging learning environment. In trying to advocate for the use of immersive learning in our higher institutions and keep abreast of the evolving world, there is need to find out the relationship between immersive learning and proficiency in machine operations among technology education students in higher institutions in Anambra State.

Statement of Problem

What is obtainable in many higher institutions in Anambra State is that students are often exposed to limited hands-on practice, they lack confidence, make more errors and face poor employment prospects due to inadequate practical competencies. As observed by Ogunmola (2023), accidents do occur wherever work is done with machines or hand tools, causing injuries to people, damage to machines, tools and materials. Probably the students are scared by the occurrence of accidents. Immersive learning technologies such as VR and AR could bridge this gap by offering repeated, safe simulations that replicate real-world tasks. The current study intends to address this by investigating the relationship between immersive learning, specifically, VR and AR use in skill training.

Research Questions

The study answered the following research questions.

RQ1: What is the relationship between VR simulation usage and proficiency level in machine operations among Technology Education students in higher institutions in Anambra State?

RQ2: What is the relationship between AR tools usage and proficiency level in machine operations among Technology Education students in higher institutions in Anambra State?

METHOD

The study adopted a correlational research design. According to Nworgu (2015), correlation research survey design is used to ascertain if two or more variables relate with each other. It is therefore adequate for the study as it examined the relationship between immersive learning and proficiency in machine operations in higher intuitions in Anambra State.

The population of the study was 253 students of mechanical technology education in higher institutions in Anambra State. A sample size of 155 students was obtained using simple random sampling technique. The students were made up of male students (n = 101) and female students (n = 54). The instrument for data collection was structured questionnaire which was adapted from other studies after extensive review of literature. The instrument was structured on a five-point Likert rating scale of: Strongly Agree (SA) =5, Agree (A) =4, Neutral (N) =3, Disagree (D) =2 and Strongly disagree (SD) =1. It was validated by three experts, two experts from the Department of Industrial Technology Education and one expert from the Department of Education Foundation, both from Nnamdi Azikiwe University, Awka. The reliability of the instrument was established using Cronbach alpha's method with the reliability coefficients of 0.73 and 0.85 respectively. Data were collected by the researchers with the help of three research assistants. Data collected relating to the two research questions were analyzed using Pearson product moment correlation. The analyses were computed using the Statistical Package for Social Sciences (SPSS version 27).

RESULTS

Relationship between VR simulation usage and proficiency level in machine operations (PMO) among Technology Education students in higher institutions in Anambra State

Table 1: Virtual Reality and Proficiency in Machine Operation

Source of Variation	N	VR	PMO	Remark
Virtual Reality (VR)	155	1.000	.395	**MPR**
Proficiency in Machine Operation (PMO)	155	.395	1.000	

Note: MPR = Moderate Positive Relationship

Table 1 presents the Pearson Product-Moment Correlation (PPMC) analysis on the relationship between the use of Virtual Reality (VR) simulations and students' proficiency in machine operations. The analysis shows a correlation coefficient of r = 0.395 with a sample size of N = 155. The correlation value is positive, indicating that an increase in the use of VR simulations is associated with an increase in students' proficiency in machine operations. Since the coefficient (0.395) is moderate, it suggests that while VR simulations contribute positively to students' proficiency, other factors may also influence performance in machine operations.

Relationship between AR tools usage and proficiency level in machine operations (PMO) among Technology Education students in higher institutions in Anambra State

Table 2: Augmented Reality Tools Usage and Proficiency in Machine Operation

Source of Variation	N	AR	PMO	Remark
AR tools usage	155	1.000	.656	**SPR**
Proficiency in Machine Operation (PMO)	155	.656	1.000	

Note: SPR = Strong Positive Relationship

Table 2 presents the Pearson Product-Moment Correlation (PPMC) analysis on the relationship between AR tools usage and students' proficiency in machine operations. The analysis shows a correlation coefficient of r = 0.656 with a sample size of N = 155. The correlation value is positive, indicating that an increase in the use of AR tools is associated with an increase in students' proficiency in machine operations. Since the coefficient value of 0.656 suggests a high positive relationship, this means AR tools are highly effective in enhancing students' machine operation proficiency compared to VR simulations (r = 0.395). The strength of this relationship highlights AR tools as a more influential

instructional technology for improving hands-on competence in mechanical technology education in Anambra State.

DISCUSSION

The finding of this study on Table 1 revealed a moderate positive relationship. This finding resonates with Mamani-Choque et al. (2025), who concluded that immersive tools are effective in promoting creativity and practical skills, which mirrors the present finding that VR contributes to the development of machine operation proficiency. However, while Mamani-Choque et al. highlighted strong effects, the current study shows only a moderate relationship, suggesting that VR simulations alone may not be sufficient for high-level mastery of machine operations in higher instiutions in Anambra State. Kuhail et al. (2022) also emphasized the role of VR in enhancing engagement and comprehension in STEM education, particularly through head-mounted displays. This aligns with the present study, as students exposed to VR simulations reported improved engagement and understanding in machine operations. Furthermore, the finding aligns with Al Mufida et al. (2022), who showed that immersive virtual learning improved students' conceptual mastery and thinking skills. However, the moderate strength of the relationship in this study contrasts with Al Mufida et al.'s stronger results, highlighting possible variations in the effectiveness of VR across different subject domains and regions.

The study further revealed on Table 2 that there is a high positive relationship of 0.656 between AR tools usage and proficiency in machine operation. The finding aligns with Mamani-Choque et al. (2025), who revealed that immersive learning environments foster technological competencies by allowing students to design, implement, and validate solutions in practical contexts. AR, with its ability to overlay digital elements onto real-world settings, enhances the relevance and interactivity of learning, thereby strengthening students' proficiency. It also corresponds with Kuhail et al. (2022), who noted that marker-based AR is one of the most widely adopted immersive technologies in education.

The result further support the findings of Al Mufida et al. (2022), who reported that immersive virtual learning improved students' mastery of abstract concepts. The strong relationship suggests that AR is particularly effective in bridging the gap between theoretical knowledge and practical application in technology education. This study confirms that AR tools not only boost technical proficiency but also improve motivation and engagement. This is in consonant with the study of Soelistya et al. (2023) who found that immersive learning enhances both academic and emotional aspects of learning. Students using AR are provided with interactive, real-world simulations that stimulate both cognitive and affective learning outcomes. Above all, immersive learning environments created by AR/VR technologies significantly increase student engagement and motivation compared to traditional methods (Anum & Apriyanto (2025).

CONCLUSION

Based on the findings of this study, it is concluded that both Virtual Reality and Augmented Reality serve as effective immersive learning technologies that enhance proficiency in machine operations among Industrial Technology Education students. While VR simulations provide meaningful benefits by improving visualization and conceptual engagement, their effect is only moderate. In contrast, AR tools significantly strengthen students' machine operation skills due to their capacity to overlay digital content onto real-world contexts, thereby bridging the gap between theoretical knowledge and practical application.

RECOMMENDATIONS

The following recommendations were made based on the findings of the study:

1. Higher institutions should integrate both VR and AR tools into Industrial Technology Education curricula, with particular emphasis on AR due to its stronger influence on proficiency in machine operations.
2. Adequate resources and facilities should be provided to ensure accessibility and effective utilization of immersive technologies. This includes funding for AR/VR laboratories, head-mounted devices, and digital infrastructure.

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