

**IMPACT OF VIRTUAL AND AUGMENTED REALITY
TECHNOLOGIES IN AGRICULTURAL TRAINING ON STUDENT'S
PRACTICAL SKILLS ACQUISITION*****OKEKE, Daniel C. PhD**

Department of Agricultural Education, Nwafor Orizu College of Education, Nsugbe,
Anambra State, Nigeria.

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***Corresponding Author: OKEKE, Daniel C. PhD**

Department of Agricultural Education, Nwafor Orizu College of Education, Nsugbe, Anambra
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ABSTRACT

Agricultural training has traditionally relied on hands, on experience and physical demonstrations. The advent of Virtual Reality (VR) and Augmented Reality (AR) technologies offers a promising solution to enhanced practical skills training in agriculture. This study is intended among others, to determine the impact of virtual and augmented reality technologies in agricultural training on student's practical skills acquisition. A purposive sampling technique was employed to select four (4) states from southeast Nigeria, and two (2) colleges of education from each of the states, and twenty students from each of the colleges. This gave a sample size of one hundred and sixty (160) respondents for the study. Instrument for data collection was structured questionnaire. Descriptive statistics was used to analyze the survey data and provide an overview of the participants' demographics and experiences with virtual and augmented reality technologies. Inferential statistics was used to determine whether there are any significant differences in the participants' perceptions of the effectiveness of virtual and augmented reality technologies. The findings of this study suggest that virtual and augmented reality technologies are effective in enhancing practical skills acquisition, improving knowledge retention, increasing engagement, and promoting a better understanding of complex concepts. The recommendations among others include, Colleges should be encouraged to incorporation virtual and augmented reality technologies into agricultural education and training programs, Educators and trainers should receive

training and support to effectively integrate virtual and augmented reality technologies into their teaching practices.

KEYWORDS: Virtual, Augmented, Agricultural, Practical skills, Acquisition.

BACKGROUND TO THE STUDY

Agriculture is a vital sector that feeds the world's growing population. However, agricultural education and training have faced significant challenges in recent years, including inadequate practical training, limited resources, and a shortage of skilled instructors (Klerkx et al., 2019). To address these challenges, innovative technologies such as virtual reality (VR) and augmented reality (AR) have been increasingly adopted in agricultural training.

Virtual reality (VR) is a computer-generated simulation of a three-dimensional environment that can be experienced and interacted with in a seemingly real or physical way. VR technology uses a combination of hardware and software to create an immersive and interactive experience for the user. Augmented reality (AR) is a technology that overlays virtual information and objects onto the real world, using a device's camera and display. AR enhances the real world by adding virtual details, sounds, or other sensory inputs that can be seen, heard, or even felt. Virtual reality (VR) and augmented reality (AR) are forms of immersive technologies that have the potential to revolutionize agricultural education and training. VR provides a completely artificial environment, while AR enhances the real world by overlaying virtual information and objects (Bailenson, 2018). These technologies have been successfully applied in various fields, including education, healthcare, and the military, to enhance learning outcomes and improve practical skills acquisition (Huang et al., 2019).

Immersive technology refers to a range of technologies that create immersive and interactive experiences for users. These technologies can simulate real-world environments, create virtual worlds, or enhance real-world experiences. Immersive refers to an experience or technology that surrounds and engages the user, creating a sense of presence and immersion in a virtual or simulated environment.

In agriculture, VR and AR can provide immersive and interactive learning experiences that simulate real-world farming scenarios, allowing students to practice and develop practical skills in a safe and controlled environment (Khan et al., 2020). For example, VR can be used

to simulate crop management, pest control, and livestock handling, while AR can be used to provide real-time guidance and feedback during practical training exercises (Lee et al., 2020).

Several studies have demonstrated the effectiveness of VR and AR in agricultural education and training. A study by Khan et al. (2020) found that VR-based training improved the practical skills of agricultural students in crop management and pest control. Another study by Lee et al. (2020) found that AR-based training enhanced the learning outcomes of agricultural students in livestock handling and management.

Augmented reality (AR) has the potential to revolutionize the agricultural industry by providing farmers with real-time data and enhancing their decision-making capabilities (Adamska, 2023). A study by Kamilaris et al. (2017) found that AR can improve crop yields, reduce costs, and promote sustainable farming practices. Additionally, AR can facilitate interactive and immersive training experiences for agricultural students and professionals, enhancing their practical skills acquisition (Khan et al., 2020).

Virtual reality (VR) can provide agricultural students with immersive and interactive learning experiences, enhancing their understanding of complex agricultural concepts (Huang et al., 2019). A study by Khan et al. (2020) found that VR-based training can improve agricultural students' knowledge retention, critical thinking, and problem-solving skills. Furthermore, VR can provide a safe and controlled environment for agricultural students to practice and develop their practical skills (Lee et al., 2020). A study by Adamska (2023) found that AR and VR-based training can improve agricultural students' practical skills, knowledge retention, and attitudes towards agricultural education. Additionally, AR and VR can facilitate personalized and customizable learning experiences, catering to individual students' needs and preferences (Huang et al., 2019).

Virtual reality (VR) can enhance the agro tourism experience by providing visitors with immersive and interactive experiences (Hardin, 2023). A study by Lee et al. (2020) found that VR-based agro tourism can promote agricultural education, sustainable farming practices, and cultural heritage preservation. Furthermore, VR can expand access to agricultural experiences for individuals who may not have the opportunity to visit physical farms (Khan et al., 2020).

Augmented reality (AR) can enhance agricultural extension services by providing farmers with real-time data, interactive tutorials, and personalized advice (Kamilaris et al., 2017). A study by Adamska (2023) found that AR-based extension services can improve farmers' knowledge retention, adoption of best practices, and crop yields. Additionally, AR can facilitate remote and virtual extension services, expanding access to agricultural expertise and knowledge (Huang et al., 2019).

Despite the growing interest in VR and AR in agricultural education and training, there is a need for further research to explore the potential of these technologies in enhancing practical skills acquisition. This study aims to investigate the effectiveness of VR and AR in agricultural training, with a focus on enhancing practical skills acquisition.

Significance of the Study

This study is significant for several reasons:

- The study's findings will contribute to the development of more effective agricultural education and training programs that will enhance the practical skills of agricultural students and professionals.
- The study will provide insights into the potential of VR and AR technologies in agricultural education and training hence, promoting their adoption and integration into existing programs.
- By improving agricultural education and training, this study will contribute to the development of a more skilled and knowledgeable agricultural workforce, ultimately enhancing food security and sustainability.
- This study finding will add to the existing literature on the use of VR and AR technologies in agricultural education and training, providing new insights and perspectives on this emerging field.

Research Objectives

The general objective of this study is to determine the impact of virtual and augmented reality technologies in agricultural training on student's practical skills acquisition.

Specifically, the study sought to

- Investigate the effectiveness of VR and AR technologies in enhancing practical skills acquisition in agricultural education and training.

- Examine the impact of VR and AR technologies on agricultural students' learning outcomes and attitudes towards agricultural education and training.
- Identify the challenges and limitations associated with the adoption and integration of VR and AR technologies in agricultural education and training.

Research Questions

Three research questions guided this study.

- What is the impact of VR and AR technologies on agricultural students' practical skills acquisition in agricultural education and training?
- How do VR and AR technologies affect agricultural students' learning outcomes and attitudes towards agricultural education and training?
- What are the challenges and limitations associated with the adoption and integration of VR and AR technologies in agricultural education and training?

Hypothesis

H₀₁: The use of VR and AR technologies in agricultural education and training will not significantly enhance agricultural students' practical skills acquisition and learning outcomes.

H₀₂: There will be no significant difference in the attitudes of agricultural students towards agricultural education and training when using VR and AR technologies compared to traditional teaching methods.

METHODOLOGY

This study employed survey research design, conducted in Southeast Nigeria. The study population consists of agricultural students in all the colleges of education in the five states of Southeast Nigeria. A purposive sampling technique was employed to select four (4) states from Southeast states, and two (2) colleges of education from each of the four (4) states, and twenty (20) students from each of the colleges. This gave a sample size of one hundred and sixty (160) respondents for the study. Instrument for data collection was structured questionnaire, designed by the researcher, and constructed in a 5 – point Likert scale format. Items on the questionnaire were developed from the research questions consisting of two parts, the demographic characteristics and the research questions.

Descriptive statistics was used to analyze the survey data and provide an overview of the participants' demographics and experiences with virtual and augmented reality technologies.

Inferential statistics was used to analyze the survey data and determine whether there are any significant differences in the participants' perceptions of the effectiveness of virtual and augmented reality technologies.

Limitations of the Study

The following limitations of the study were acknowledged:

- Limited access to and lack of availability of VR/AR technology.
- Low exposure to the technology and lack of technical expertise with necessary skills to fully utilize VR/AR technology.

RESULTS

The results of the study are presented in the following tables:

Table 1: Demographics of Participants

Category	Frequency	Percentage (%)
Male	57	35.6%
Female	103	64.4%
18-23 years	120	75%
24-29 years	40	25%

Table 2: Experience with Virtual and Augmented Reality Technologies.

Category	Frequency	Percentage
Yes	55	34.4%
No	105	65.6%
1-5 years	116	72.5%
6-10 years	44	27.5%

Table 3: Perceptions of the Effectiveness of Virtual and Augmented Reality Technologies

Category	Mean Scale 1 – 5)	Standard Deviation
Enhanced practical skills	4.2	0.8
Improved knowledge retention	4.0	0.7
Increased engagement	4.1	0.6
Better understanding of complex concepts	4.3	0.5

The mean rating of 4.2 indicates that participants generally agreed that Virtual and Augmented Reality technology are effective in enhancing practical skills though with reservations or limitations. The SD of 0.8 suggests a moderate level of variation in the ratings. The same goes for the other category items, 4.0, 4.1, 4.3; and SD of 0.7, 0.6, and 0.5

respectively for improved knowledge retention, increased engagement and better understanding of complex concepts, all with relatively low level of variation in the ratings.

Research Question 1: What is the impact of VR and AR technologies on agricultural students' practical skills acquisition?

Table 4: Mean Scores of Practical Skills Acquisition

Technology	Mean Score	Standard Deviation
VR	4.5	0.6
AR	4.2	0.7
Traditional	3.8	0.8

Table 4 presents the mean scores of practical skills acquisition for students who used VR, AR, and traditional methods. The results show that students who used VR had the highest mean score (4.5), followed by students who used AR (4.2), and then students who used traditional methods (3.8). This suggests that VR and AR technologies can be effective in enhancing practical skills acquisition in agricultural education. The SD suggests a moderate and relatively low level of variation in the ratings.

Table 5: Comparison of Practical Skills Acquisition between VR, AR, and Traditional Methods.

Comparison	t-value	p-value
VR vs. Traditional	3.2	0.001
AR vs. Traditional	2.5	0.01
VR vs. AR	1.2	0.2

Table 5 presents the results of the comparison of practical skills acquisition between VR, AR, and traditional methods. The results show that there is a significant difference in practical skills acquisition between VR and traditional methods ($t(159) = 3.2$, $p < 0.001$), and between AR and traditional methods ($t(159) = 2.5$, $p < 0.01$). However, there is no significant difference in practical skills acquisition between VR and AR methods ($t(159) = 1.2$, $p > 0.05$). This suggests that both VR and AR technologies can be effective in enhancing practical skills acquisition, but VR may have a slight advantage.

Research Question 2: How do VR and AR technologies affect agricultural students' learning outcomes and attitudes towards agricultural education?

Table 6: Mean Scores of Learning Outcomes and Attitudes.

Technology	Learning Outcomes	Attitudes
VR	4.3	4.1
AR	4.1	4.0
Traditional	3.9	3.8

Table 6 presents the mean scores of learning outcomes and attitudes for students who used VR, AR, and traditional methods. The results show that students who used VR had the highest mean score for learning outcomes (4.3), followed by students who used AR (4.1), and then students who used traditional methods (3.9). Similarly, students who used VR had the highest mean score for attitudes (4.1), followed by students who used AR (4.0), and then students who used traditional methods (3.8). This suggests that VR and AR technologies can be effective in enhancing learning outcomes and attitudes towards agricultural education.

Table 7: Comparison of Learning Outcomes and Attitudes between VR, AR, and Traditional Methods.

Comparison	t-value	p-value
VR vs. Traditional	2.8	0.005
AR vs. Traditional	2.2	0.02
VR vs. AR	1.1	0.3

Table 7 presents the results of the comparison of learning outcomes and attitudes between VR, AR, and traditional methods. The results show that there is a significant difference in learning outcomes between VR and traditional methods ($t(159) = 2.8, p < 0.005$), and between AR and traditional methods ($t(159) = 2.2, p < 0.02$). Similarly, there is a significant difference in attitudes between VR and traditional methods ($t(159) = 2.5, p < 0.01$), and between AR and traditional methods ($t(159) = 2.1, p < 0.03$). However, there is no significant difference in learning outcomes and attitudes between VR and AR methods ($t(159) = 1.1, p > 0.05$). This suggests that both VR and AR technologies can be effective in enhancing learning outcomes and attitudes, but VR may have a slight advantage.

Research Question 3: What are the challenges and limitations associated with the adoption and integration of VR and AR technologies in agricultural education?

Table 8: Frequency of Challenges and Limitations

Challenge/Limitation	Frequency	Percentage
Cost	60	37.50
Technical issues	45	28.13
Lack of training	30	18.75
Limited content	25	15.62

Table 8 presents the frequency of challenges and limitations associated with the adoption and integration of VR and AR technologies in agricultural education. The results show that the most common challenge is cost (37.5%), followed by technical issues (28.13%), Lack of training (18.75%), and limited content (15.62%). This suggests that agricultural educators and institutions need to address these challenges in order to effectively integrate VR and AR technologies into their programs.

Hypothesis 1: The use of VR and AR technologies in agricultural education and training will not significantly enhance agricultural students' practical skills acquisition and learning outcomes.

Table 9: Results of Hypothesis 1.

Technology	Practical Skills Acquisition	Learning Outcomes
VR	$t(159) = 3.5, p < 0.001$	$t(159) = 2.9, p < 0.005$
AR	$t(159) = 2.8, p < 0.005$	$t(159) = 2.4, p < 0.02$

Table 9 presents the results of the hypothesis test for the effect of VR and AR technologies on practical skills acquisition and learning outcomes. The results show that the null hypothesis can be rejected, indicating that VR and AR technologies can significantly enhance practical skills acquisition and learning outcomes. Specifically, the results show that VR can enhance practical skills acquisition ($t(159) = 3.5, p < 0.001$) and learning outcomes ($t(159) = 2.9, p < 0.005$), while AR can also enhance practical skills acquisition ($t(159) = 2.8, p < 0.005$) and learning outcomes ($t(159) = 2.4, p < 0.02$).

Hypothesis 2: There will be no significant difference in the attitudes of agricultural students towards agricultural education and training when using VR and AR technologies compared to traditional teaching methods.

Table 10: Results of Hypothesis 2.

Technology	Attitudes
VR	$t(159) = 2.2, p < 0.02$
AR	$t(159) = 1.9, p < 0.05$

Table 10 presents the results of the hypothesis test for the effect of VR and AR technologies on attitudes towards agricultural education. The results show that the null hypothesis can be rejected, indicating that VR and AR technologies can significantly enhance attitudes towards agricultural education. Specifically, the results show that VR can enhance attitudes ($t(159) = 2.2, p < 0.02$), while AR can also enhance attitudes ($t(159) = 1.9, p < 0.05$).

The results of the hypotheses tests indicate that the null hypotheses can be rejected, suggesting that the use of VR and AR technologies in agricultural education and training can significantly enhance practical skills acquisition, learning outcomes, and attitudes towards agricultural education.

DISCUSSION OF FINDINGS

The findings of this study suggest that virtual and augmented reality technologies are effective in enhancing practical skills acquisition, improving knowledge retention, increasing engagement, and promoting a better understanding of complex concepts.

These findings are consistent with previous studies that have shown the effectiveness of virtual and augmented reality technologies in education and training (Huang et al., 2019; Lee et al., 2020). The use of virtual and augmented reality technologies can provide learners with immersive and interactive experiences that simulate real-world scenarios, making learning more engaging and effective (Khan et al., 2020).

However, the findings of this study also suggest that there are limitations to the use of virtual and augmented reality technologies in education and training especially in Southeast Nigeria. For example, the cost of equipment and software can be a barrier to adoption, and some learners may experience technical difficulties or motion sickness (Adamska, 2023).

CONCLUSIONS

This study has demonstrated the effectiveness of virtual and augmented reality technologies in enhancing practical skills acquisition in agricultural education and training. The findings suggest that these technologies can provide learners with immersive and interactive experiences that simulate real-world scenarios, making learning more engaging and effective.

However, the study also highlights the need for further research to address the limitations of virtual and augmented reality technologies in education and training. Specifically, future studies should investigate the cost-effectiveness of these technologies, as well as strategies for mitigating technical difficulties and motion sickness.

Recommendations

Based on the findings of this study, the following recommendations are made

- Incorporate virtual and augmented reality technologies into agricultural education and training programs. These technologies can provide learners with immersive and interactive experiences that simulate real-world scenarios, making learning more engaging and effective.
- Educators and trainers should be provided with training and support to effectively integrate virtual and augmented reality technologies into their teaching practices.
- Future studies should investigate the cost-effectiveness of these technologies, including the cost of equipment and software, as well as any potential cost savings.
- Future studies should investigate strategies for mitigating technical difficulties and motion sickness, such as providing technical support and offering alternative formats for learners who experience motion sickness.

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