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Effect of Augmented Reality on the Academic Performance of Undergraduate Students in Econometrics in Northwest, Nigeria

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Abstract: ***The paper investigated the effect of augmented reality on the academic performance of undergraduate students in econometrics in the northwest, Nigeria. The paper sought to determine whether there was a difference in the academic performance of the students taught using AR and those taught the same using a traditional approach. The study adopted a quasi-experimental design. The population of the study involved all 300-level students in the two universities under the study. Intact classes of 41 and 31 students were selected as experimental and control groups respectively. An augmented reality (Simple Boy) was used as the treatment, and an econometrics test instrument (ETI) was used as a research instrument for the study. The instrument was validated by experts, and subjected to a pilot study. A reliability index of 0.76 was obtained using KR-21. The study found that there was a significant difference in the academic performance of the students taught using the AR and those taught the same content using the traditional approach in favour of those taught using the AR. There was also a significant difference in the academic performance of the students taught using the AR-based on gender, in favour of female students. The study concluded that augmented reality is an emerging technology that if used diligently in the instructional process is capable of revolutionizing education in the 21st century. There is no doubt that the technology is effective in improving students' active participation in the learning process which in turn promotes students' academic performance at all levels of education. It was recommended that Based on the findings of the study, it is recommended that researchers should design and develop augmented reality apps and test their effectiveness in different scenarios and different learning environments. This would help to further ascertain its strengths and weaknesses for quality assurance, control, and integration in the education sector.***

Keywords: Augmented Reality, Academic Performance, Econometrics, Undergraduates.

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1. INTRODUCTION

Traditional classroom learning and approaches are being supplanted by new emerging technology on a daily basis. It will also not be incorrect to state that when education smart is introduced, digital tools such as smartphones, tablets, and laptops are used in classrooms for learners of virtually all ages. The advancement of digital technology has imposed and continues to impose significant changes in education systems around the world, whether we are talking about teaching-learning methods or the organization of courses, as well as the skills and talents of teachers and students. As a result, it is vital to constantly innovate instructional approaches in order to keep up with the current rate of technological advancement [10]. Students benefit from a variety of technologies and digital tools, one of which is augmented reality (AR), which enhances the real-life description of the topic in no time, making the content more engaging and comprehensible for the student, as well as making them remember and learn it for a long time [13]. AR is the extent to which computer displays can deliver an inclusive, extensive, surrounding, and the vivid illusion of reality to a human participant's senses [14]. Augmented reality is a technology that acts as a bridge between the real and virtual worlds, with the connection maintained through synchronous interactions, and it provides a plethora of benefits and gains when used in education due to its ability to allow interaction with virtual and real objects, to learn by doing, and to increase attention and motivation [10].

The field of education is constantly being transformed by digital technologies [3]. Augmented Reality (AR) is rapidly redefining the possibilities in education and training [15]. Students now have access to a wealth of data and learning materials, and teachers are increasingly serving as learning facilitators [12]. Augmented reality (AR) is an immersive technology that allows users to interact with digitally produced content in both physical and virtual environments. This technology broadens the possibilities of learning environments at all levels of education by removing physical barriers, improving collaboration and hands-on learning, and providing individualized learning approaches that can help students at all levels thrive [3]. The true goal of AR is to increase student participation and foster deeper comprehension. Teachers can convey hard concepts to students in a controlled environment by making learning immersive and experiential with AR [12]. AR improves learning by incorporating digital aspects into the actual environment. This technology is already being used by certain educators and trainers to develop interesting digital content [15]. AR technology can easily accomplish anything that traditional training pedagogies cannot.

It is an undeniable fact that in the 21st century, most of the undergraduate students currently in the universities are digital natives (tech-savvy). They love and play with technologies. It is therefore a possibility that these set of learners can easily be motivated to learn when fascinating technologies such as augmented reality is integrated into the instructional process. Even though it is an emerging technology, AR has been tested and proved effective in promoting students' academic activities by different researchers. Going by the literature, one special feature of augmented reality is its ability to facilitate the teaching and learning of complex courses. In social sciences, econometrics is identified by the researcher as one of the complex undergraduate courses. It would be quite impressive if the AR is found effective in making it easy for the students to learn the econometrics without much stress which would in turn improve their academic performance. It is in line with this

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background the researcher finds it imperative to investigate the effect of the AR on the academic performance of undergraduate students in econometrics in Northwest, Nigeria.

One of the most obvious advantages of augmented reality in education is that it allows students to interact with 3D models of various objects. Students can also use this technology to access the Internet straight from their mobile devices. Students can get more information about a subject by scanning a photo that is linked to an AR model throughout the instructional process. This learning cycle aids in the retention of knowledge by students. The combination of a picture, a model, and information boosts a student's learning ardour while also improving memory [7].

AR in education can provide multiple benefits, not only in terms of a shift from traditional to digital but it is also said to have improved and effectively impacted student understanding and interaction, resulting in good results and an in-depth understanding of the concept. As a result, the combination of interactive education and engaging content can cause students to remember what they have learned and gain fast skills and information in a short period of time and with little stress. AR can be used in practically all courses taught to students of all ages, whether at the elementary or secondary level. There are numerous roles and implications of augmented reality that can be seen in the field of education. This is not only setting a trend for new learning methods and modern-era education, but it is also playing an important part in altering the old educational strategy that has been applied [13]. Another advantage of AR is its simplicity. Learning can now be made interactive thanks to advances in technology. Technology assists students in learning concepts more easily as long as they have access to educational models on their devices. AR, for example, can assist students in recreating previously inaccessible locations. It also allows teachers to provide additional educational materials and resources that supplement the lecture. Using these technologies, educators may help students learn more about a subject by engaging them in hands-on activities [7].

Augmented reality-based education has the ability to replace outdated approaches and textbook-based reading. However, because not everything can be transferred to technology-enhanced right away, one should begin with a mixed strategy for both AR-based learning and traditional-based learning. Augmented reality-based learning, which is now being used in the majority of educational learning apps and platforms, is assisting students with their present studies and advertising themselves as how they are helping them improve their grades by better grasping the concept. AR-based classroom courses (Smart Class) or even virtual application-based classrooms on smartphones make pupils more participatory. When students are able to understand more and more clearly, as previously stated, they are also able to think beyond the confines of the classroom [13]. The most important advantage of augmented reality in education is its ability to make learning enjoyable. Most learning management software and applications already have this technology, and it can be incorporated into a learning environment without changing the content of the classroom. The majority of these programs will keep pupils engaged in the material by locking the answers. Furthermore, they can make exams more fascinating and enjoyable for pupils [7].

AR serves as a broad means of comprehension and an educational procedure that is proven to be more successful than ever for most students. These smart education projects, regardless of where they are taught to whatever type of students, if they are on public access portals, and if they are on an application that functions similarly to that, may be accessed

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from literally anywhere [13]. AR does not necessitate the purchase of pricey gear. AR technologies are immediately available for use for the bulk of the target population, as 73 percent of teenagers now own a smartphone. AR apps provide several options to diversify and enliven monotonous courses. Interactive classes, in which all students participate in the learning process at the same time, aid in the development of collaborative skills [10].

Many studies have demonstrated that technology can help pupils improve their academic performance. Another new learning technology discovery is augmented reality. Various research has demonstrated that AR can lead to improvements in students' academic achievement. [1] study on the influence of augmented reality-based applications on achievement and attitude toward scientific courses in distance education indicated that augmented reality statistically boosts student achievement in science. In other words, augmented reality improves the success rate of online courses in the distance education process. Another study conducted by [9] to investigate the effect of augmented reality (AR) applications on K-12 students' academic accomplishments by meta-analysis and theme analysis found that AR had a medium effect on K-12 students' academic achievement.

In a study on the impact of augmented reality technology on the academic achievement and motivation of students from public and private Mexican schools, [6]: In a case study of a middle-school geometry course, pupils who used the augmented reality-based learning environments outperformed those who used the web-based program on the post-test. An AR-supported education was found to be beneficial in boosting students' academic performance in tertiary-level medical education in another study [2]. There was a substantial difference in academic performance between pupils taught using AR and those taught using the traditional technique [17]. Similarly, a study conducted by [8] on the effects of augmented reality apps on first graders' motivation and performance in English vocabulary learning discovered that incorporating AR apps into English vocabulary learning can significantly improve first graders' motivation and performance in English vocabulary learning. Another study on the impact of augmented reality apps to boost students' achievement in learning animals found that using Augmented Reality (AR) book app media greatly improved students' learning performance. Students in this study indicated that the experimental group's learning outcome was superior to the control group's [11].

Gender has been identified as a factor that may influence students at all levels of education's use of technology for learning. Augmented reality is a new technology that is rapidly gaining traction in the education industry around the world. As a new technology, its incorporation into the educational process may be influenced by gender as a variable. A study on the gender disparities in cognitive burdens in an augmented reality-based warehouse conducted by [16] discovered that female students did better than males when taught via AR technology (headset). [4] conducted a similar study and discovered that female participant were more excited about the use of new technology (AR) than males. The user experience of AR and traditional videos elicited more favorable feelings in women than in men.

[5] conducted a study on the benefits of augmented reality in sustaining working memory in assembly tasks: With an emphasis on gender differences, researchers discovered that AR was successful in helping both male and female trainees learn the assembly process faster. According to the findings of the study, AR is gender-friendly.

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Objectives of the Study

The main purpose of the study was to determine the effect of Augmented Reality (Simple Boy) on the academic performance of university students in Econometrics in Kebbi and Sokoto States, Nigeria. Specifically, the study intended to:

1. Ascertain whether there is a difference in the academic performance of the undergraduate students taught Econometrics using Augmented Reality and those taught using conventional approach.
2. Determine whether the performance of the undergraduate students taught using the Augmented Reality would vary based on gender.

Research Questions

The following questions were raised to guide the study:

1. What is the difference in the academic performance of the undergraduate students taught Econometrics using Augmented Reality and those taught using conventional approach?
2. Do the performance of the undergraduate students taught using the Augmented Reality vary based on gender?

Research Hypotheses

The following hypotheses were tested in the study:

H01 The is no significant difference in the academic performance of the undergraduate students taught Econometrics using Augmented Reality and those taught using conventional approach.

H02 There is no significant difference in the academic performance of the undergraduate students taught using the Augmented Reality based on gender.

2. METHODOLOGY

This study adopted a quasi-experimental design where two groups were involved. Pretests and posttests were conducted for the groups. The population of the study includes all the undergraduate students of the Economics Departments from Federal University Birnin Kebbi and Usmanu Danfodiyo University, Sokoto. An intact class of 300-level students was purposively selected from each of the two Universities as the sample for the study. 41 and 31 undergraduate students were allocated to the experimental and control groups respectively from Federal University Birnin Kebbi and Usmanu Danfodiyo University, Sokoto. An Augmented Reality (Simple Boy) was used as a treatment for the experimental group. An achievement test instrument pegged “Econometrics Test Instrument” (ETI) was developed by the researcher, and validated by experts. The instrument was subjected to a pilot study, and a reliability index of 0.76 was obtained using Kurder-Richardson 21 (KR-21). In this study, two groups (experimental and control) were involved. The groups were pretested, and after four weeks of instructions (treatment), posttests were conducted. The research questions raised were answered using descriptive statistics (mean), and the two hypotheses of the study were tested using inferential statistics (t-test) at a 0.05 level of significance.

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3. RESULTS

RQ1: What is the difference in the academic performance of the undergraduate students taught Econometrics using Augmented Reality and those taught using conventional approach?

Table I: Descriptive statistics results for the experimental and control groups

Variables	N	Pretest Mean	Posttest Mean	Mean Gain Score
Exp. Group	31	3.91	8.54	4.63
Cont. Group	41	3.97	5.45	1.48
Total Mean Diff	72	0.06	3.09	3.15

From the table I, it could be seen that the experimental and control groups had pretest mean scores of 3.91 and 3.97 respectively. After the treatment, the posttests mean scores for the experimental and control groups respectively are 8.54 and 5.45. The mean gained difference of 3.15 indicated that there was a difference in the academic performance between the two groups in favour of the experimental group.

RQ2: Do the performance of the undergraduate students taught using the Augmented Reality vary based on gender?

Table II: Descriptive statistics for the male and female students taught using the Augmented Reality

Variables	N	Pretest Mean	Posttest Mean	Mean Gain Score
Male	23	3.87	8.04	4.17
Female	18	3.94	9.17	5.23
Total Mean Diff	41	0.07	1.13	1.06

The results from table II indicated that the males and females had pretest mean scores of 3.87 and 3.94 respectively. After the treatment, the posttests mean scores for the males and females respectively are 8.04 and 5.23. The mean gained difference of 1.06 indicated that there was a difference in the academic performance between males and females in favour of the females.

Hypotheses Testing

$H0_1$ The is no significant difference in the academic performance of the undergraduate students taught Econometrics using Augmented Reality and those taught using conventional approach.

Table III: t-test results for the experimental and control groups

Variables	N	Mean	Df	t-Cal	P-Value	Sig.
Exp. Group	31	8.54				
			70	12.45	0.000	$H0_2$ Rejected
Cont. Group	41	5.45				

Table III revealed the t-test results in respect of the null hypothesis. The mean score for the experimental and control group were respectively 8.54 and 5.45. The t-cal 12.45, $p<0.05$ (two

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tailed) revealed that there was significant difference in the academic performance of the students taught using Augmented Reality and those taught using conventional instruction. In favor of the experimental group (those taught using Augmented Reality (Simple Boy)). Thus the null hypothesis was rejected.

$H0_2$ There is no significant difference in the academic performance of the undergraduate students taught using the Augmented Reality based on gender.

Table IV: t-test results for the male and female students taught econometrics using Augmented Reality

Variables	N	Mean	Df	t-Cal	P-Value	Sig.
Male	23	8.04				
			39	3.46	0.001	$H0_1$ Rejected
Female	18	9.17				

Table IV showed the result of t-test in respect of the null hypothesis. The mean score for the males and females were respectively 8.04 and 9.17. The t-cal 3.46, $p<0.05$ (two tailed) revealed that there was significant difference in the academic performance of the male and female students in Econometrics. In favor of the female students. Thus the null hypothesis was rejected.

4. DISCUSSIONS

Results from the study found that augmented reality was effective in improving students' academic performance in Econometrics. A hypothesis tested revealed that there was a significant difference in the academic performance of the students taught econometrics using the augmented reality and those taught the same content using the traditional approach, in favour of the experimental group (those taught using the augmented reality. From the literature, it has been affirmed that augmented reality developed to teach a different set of students proved to be effective in promoting academic performance. Augmented reality has some features that promote learner active engagement in the learning process. It motivates learners' interests which are considered a rudiment factor in the learning process. In line with the finding of the study, [7] opined that the most important advantage of augmented reality in education is its ability to make learning enjoyable. [13] added that augmented reality in education can provide multiple benefits, not only in terms of a shift from traditional to digital but it is also said to have improved and effectively impacted student understanding and interaction, resulting in good results and an in-depth understanding of the concept. As a result, the combination of interactive education and engaging content can cause students to remember what they have learned and gain fast skills and information in a short period of time and with little stress.

The course taught through the use of augmented reality has been considered a complex subject to many students of economics. Augmented reality has the ability to make it easy for the students to understand complex concepts without much stress. This could be one of the reasons the technology was found effective. In line with this idea, [10] asserted that AR technologies provide several options to diversify and enliven monotonous courses. Interactive classes, in which all students participate in the learning process at the same time, aid in the

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development of collaborative skills. Moreover, augmented reality assists students in learning concepts more easily as long as they have access to educational models on their devices. AR, for example, can assist students in recreating previously inaccessible locations. It also allows teachers to provide additional educational materials and resources that supplement the lecture. Using these technologies, educators may help students learn more about a subject by engaging them in hands-on activities [7].

Apart from its capabilities of promoting learner active engagement in the learning process, results from this study also revealed that augmented reality was more effective in promoting academic performance than other traditional approaches to the instructional process. In agreement with the finding, [1] asserted that augmented reality statistically boosts student achievement in science. Similarly, [9] found in their study that AR had a medium effect on K-12 students' academic achievement. To further support the finding of the study, [6] affirmed that pupils who used the augmented reality-based learning environments outperformed those who used the web-based program on the post-test. An augmented reality-supported education was found to be beneficial in boosting students' academic performance in tertiary-level medical education in another study [2]. Other studies that also support the finding of the study include the research from [17], [8], and [11]. Findings from their studies unanimously confirmed that using augmented reality to teach complex subjects has more effects on students' academic performance than using traditional techniques.

Another finding from this study revealed that there was a significant difference in the academic performance of the students taught using augmented reality based on gender, in favour of female students. In spite of the fact that the AR was found effective in improving students' academic performance, factors such as gender might influence students' utilization of the technology which in turn affects their active engagements as well as performance. Most of the literature reviewed in this study affirmed that female students always performed exceptionally compared to their male counterparts. A study on the gender disparities in cognitive burdens in an augmented reality-based warehouse conducted by [16] discovered that female students did better than males when taught via AR technology (headset). [4] (2019) conducted a similar study and discovered that female participant were more excited about the use of new technology (AR) than males. The user experience of AR and traditional videos elicited more favorable feelings in women than in men.

5. CONCLUSION

The learning process in 21st-century classrooms is significantly more effective and motivating thanks to developing augmented reality (AR) technologies. The incorporation of virtual content into the actual environment makes learning approaches appealing and engaging for students while they are engaged in activities. When compared to traditional ways, augmented reality approaches make learning easier and more enjoyable. Augmented reality is a developing technology that, when used diligently in the instructional process, has the potential to revolutionize education in the twenty-first century. There is no doubt that technology improves students' active participation in the learning process, which boosts students' academic success at all levels of education. Augmented reality should be designed and developed in such a way that it is gender-neutral. If this goal is met, augmented reality will be worth incorporating into school as an effective learning aid all across the world.

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Recommendations

According to the study's conclusions, researchers should design and develop augmented reality apps and assess their usefulness in various settings and learning environments. This would aid in determining its strengths and limitations in terms of quality assurance, control, and integration with the education system.

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