

EFFECT OF VIRTUAL PLATFORM ON STUDENT ACADEMIC ACHIEVEMENT IN AUTOMOTIVE
BRAKING SYSTEM IN COLLEGES OF EDUCATION (TECHNICAL)
IN NORTH-EAST, NIGERIA

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Background of the Study

The integration of Information and Communication Technology (ICT) into Technical and Vocational Education and Training (TVET) represents a strategic response to global digitalisation and the need to align workforce skills with 21st-century labour markets (Abubakar, 2021). In Nigeria, the technical and vocational education sector faces significant challenges, particularly in the North-East region, where educational infrastructure has been severely impacted by insurgency, economic disadvantages, and chronic underfunding (World Bank, 2021).

The automotive braking system, a core component of automotive technology programs in Colleges of Education (Technical), requires practical, hands-on training essential for skill acquisition. However, the region faces a critical shortage of modern functional automobile workshops, up-to-date braking system components for practicals, and inadequate consumable practical materials. Consequently, instructional delivery in automotive technology often relies heavily on theoretical and chalk-and-talk methods, which are inadequate for conveying the dynamic, hands-on skills required for troubleshooting and repairing modern braking systems (Nwagwu, 2023). This theory-practice gap results in graduates who lack the requisite technical competence, thereby contributing to the skills deficit in Nigeria's automotive industry and worsening youth unemployment.

Virtual learning platforms offer a compelling solution to many of these challenges. A virtual platform for teaching an automobile braking system can provide a cost-effective, safe, and highly interactive learning environment that allows students to explore the internal workings of a master cylinder, calipers, brake lines, and anti-lock braking system which is difficult to achieve with physical models alone (RSIS International, 2025). Trainees can perform complex procedures like brake fluid bleeding, disc and pad replacement, or troubleshooting an ABS failure without the risk of injury, damage to equipment, or the cost of consumable materials (Edquip, 2025).

Research has consistently shown that virtual learning platforms, when properly designed and integrated, can significantly enhance student academic achievement. Adesope, Oke and Odekunle (2018) found that virtual learning instructional media tracks students' work, tailoring feedback and hints along the way, and encourages the shift from teacher-centred to student-centred instruction in which students are active learners. When students are actively involved in their learning, they are more likely to remember what they did rather than what they read or heard. In other words, learning with intelligent tutor instructional media is conducive to enhancing cognitive achievement, psychomotor achievement and learning retention of students.

It is against this background that this study investigated the effect of a Virtual Platform on student academic achievement in automotive braking systems in Colleges of Education (Technical) in North-East Nigeria.

Statement of the Problem

The technical and vocational education in Nigeria, particularly in the North-East region, faces significant challenges in providing practical, hands-on training essential for skill acquisition. This is especially true for complex mechanical systems like the automotive braking system, a core

component of automotive technology programs in Colleges of Education (Technical). The region's educational infrastructure has been severely impacted by insurgency, economic disadvantages, and chronic underfunding, leading to a critical shortage of modern functional automobile workshops, up-to-date braking system components for practicals, and inadequate consumable practical materials (World Bank, 2021).

Consequently, instructional delivery in automotive technology often relies heavily on theoretical and chalk-and-talk methods, which are inadequate for conveying the dynamic, hands-on skills required for troubleshooting and repairing modern braking systems. This theory-practice gap results in graduates who lack the requisite technical competence, thereby contributing to the skills deficit in Nigeria's automotive industry and worsening youth unemployment (Nwagwu, 2023). While the integration of Information and Communication Technology (ICT) through virtual learning platforms has been proposed as a viable solution to bridge this gap by simulating practical experiences, its application in technical subjects in Nigeria remains under-explored.

Therefore, the problem is the inadequacy of virtual platforms for teaching and the lack of contextualized digital tools, which hinder the effective and efficient instruction of the automotive braking system. This study seeks to address this problem by determining the effect of a virtual platform specifically designed to enhance the teaching and learning of the automotive braking system in Colleges of Education (Technical) in North-East, Nigeria.

Purpose of the Study

The purpose of this study was to

1. Determine the effect of Virtual Platform on student academic achievement in automotive braking systems in Colleges of Education (Technical) in North-East, Nigeria.

Research Questions

The following research questions guided the study:

1. What is the mean difference between the performance of students in experimental and control groups in the pre-test?
2. What is the mean difference between the performance of students in experimental and control groups in the post-test?
3. What is the effect of VPF on academic achievement of students in automotive braking system in Colleges of Education (Technical) in North East, Nigeria?

Methodology

The study adopted a quasi-experimental research design. The study was carried out in Federal College of Education (Technical) Gombe, in Gombe State and Federal College of Education (Technical) Potiskum in Yobe State. The targeted population of the study was 1,206, which comprised all the 220 lecturers and 986 NCE II (Technical) Students for the 2025/2026 academic session from the eight NCE (Technical) awarding institutions in the study area. From the population, 343 respondents were sampled. Census sampling was adopted to use all the 73 lecturers of Automobile Technology, Computer Science, Educational Technology and Computer Programmers respectively. In the case of schools, a simple random sampling technique was used for the selection of two schools used for the study. The instrument used for data collection was the Automotive Braking System Achievement Test (ABSAT). The ABSAT consisted of 60 multiple-choice questions. The ABSAT was validated by six experts. Three experts from the Department of Technology Education, Modibbo Adama University of Technology, Yola, Adamawa State. The data collected were analysed using Cronbach Alpha Coefficient with the aid of SPSS. The data collected from the research questions were analyzed using mean and standard deviation. The null hypotheses were tested at 0.05 level of significance using independent sample t-test for hypotheses 1 and 3, and paired sample t-test for hypothesis

Results and Discussion

Research Question Two What is the mean difference between the performance of students in experimental and control groups in the pre-test?

Table 1 presents the result of research question one. The result shows that the experimental group had a mean score of 25.55 with a standard deviation of 9.239 in the pre-test, while the control group had a mean score of 25.71 with a standard deviation of 9.072. The mean difference between the two groups in the pre-test is 0.16, which is very small. This indicates that both groups had almost the same entry behaviour before the treatment.

Table 1: Mean and Standard Deviation of Pre-test Scores of Experimental and Control Groups

Table 1: Mean gain and Standard Deviation of the Experimental and Control groups' Performance in Pre-test and Post-test

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Experimental	143	25.55	9.239	61.45	15.124	35.9
Control	127	25.71	9.072	33.98	20.059	8.27

Source: 2024/25 Field work

Research Question Two What is the mean difference between the performance of students in experimental and control groups in the post-test?

Table 2 presents the result of research question two. The result shows that the experimental group had a mean score of 61.45 with a standard deviation of 15.124 in the post-test, while the control group had a mean score of 33.98 with a standard deviation of 20.059. The mean difference between the two groups in the post-test is 27.47, which is substantial. This indicates that the experimental group performed significantly better than the control group in the post-test.

Table 2: Mean gain and Standard Deviation of the Experimental and Control groups' Performance in Pre-test and Post-test

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Experimental	143	25.55	9.239	61.45	15.124	35.9
Control	127	25.71	9.072	33.98	20.059	8.27

Source: 2024/25 Field work

Research Question Three What is the effect of VPF on academic achievement of students in automotive braking system in Colleges of Education (Technical) in North East, Nigeria?

Table 3 presents the result of research question three. The result shows that the experimental group had a mean score of 25.55 in the pre-test and a mean score of 61.45 in the post-test, making a pre-test, post-test mean gain in the experimental group of 35.9. The control group had a mean score of 25.71 in the pre-test and a post-test mean of 33.98 with a pre-test, post-test mean gain of 8.27. With this result, the students in the experimental group performed better in the achievement test than the students in the control group. Hence, VPF is more effective than the lecture teaching method on students' achievement in automotive braking system.

Table 3: Mean Gain and Standard Deviation of the Experimental and Control Groups' Performance

in Pre-test and Post-test

Mean gain and Standard Deviation of the Experimental and Control groups' Performance in Pre-test and Post-test

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Source: 2024/25 Field work

Result of Hypotheses

Null Hypothesis One

Ho1: There is no significant difference between the achievement scores of experimental and control groups in the Pre-test.

Table 4 shows the result obtained when an independent sample t-test was run between the experimental and the control group at pre-test. The result shows there is no meaningful difference in the achievement scores between control and experimental groups prior to the study. Testing at an alpha level of 0.05 [$t(268) = -0.146$, $p = 0.884 > 0.05$]. The null hypothesis which states that there is no significant difference in the pre-test mean of the students taught VPF using lecture method and those taught using conventional method in Colleges of Education in North East Nigeria was retained.

Table 4: t-test Analysis for Students' Pre-test Scores for Experimental and Control Group

Groups	N	Mean	SD	Df	t-value	P-value
Experimental	143	25.55	9.239	268	-0.146	0.884
Control	127	25.71	9.072			

$p=0.789 > 0.05$ the null hypothesis is accepted

Null Hypothesis Two

Ho2: There is no significant difference between the achievement scores of experimental group in the Pre-test and Post-test.

Table 5 shows the result obtained through a paired sample t-test between pre-test and post-test scores of the experimental group. Testing at an alpha level of 0.05 [$t(142) = 25.467$; $p = 0.000 < 0.05$]. Therefore, the null hypothesis which states there is no significant difference in the post-test and pre-test mean difference of students taught automotive braking system using VPF in Colleges of Education in North East Nigeria is rejected.

Table 5: t-test Analysis for Students' Post-test and Pre-test Scores in Experimental Group

Experimental Group	N	Mean	SD	Df	t-value	P-value
Post-test	143	61.45	15.123			

143 25.467 0.000

Pre-test	143	25.55	9.239
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P=0.000 <0.05 the null hypothesis is rejected

Null Hypothesis Three

Ho3: There is no significant difference between the mean gain achievement scores of experimental and control groups in the Post-test.

Table 6 shows the result obtained when an independent sample t-test was run between the mean gain of the experimental and control group. Testing at an alpha level of 0.05 [$t(268) = 12.971$, $p = 0.000 < 0.05$]. Therefore, the null hypothesis which states there is no significant difference in the pre-test and post-test mean gain between experimental and control groups is rejected.

Table 6: t-test Analysis for Students' Difference in Pre-test and Post-test Mean Gain between Experimental and Control groups

Groups	N	Pre-test Mean	Post-test Mean	Mean gain	Df	t-value	P-value
Experimental	143	25.55	61.45	35.9	268	12.971	0.000
Control	127	25.71	33.98	8.27			

p = 0.000 <0.05 the null hypothesis is rejected

Major Findings of the Study

1. There is no significant difference between the achievement scores of experimental and control groups in the Pre-test. Both groups had almost the same entry behaviour before the treatment.
2. There is a significant difference between the achievement scores of the experimental group in the Pre-test and Post-test. The experimental group performed significantly better in the post-test than in the pre-test.
3. There is a significant difference between the mean gain achievement scores of experimental and control groups in the Post-test. The experimental group achieved a higher mean gain score (35.9) compared to the control group (8.27).
4. The Virtual Platform (VPF) is effective in enhancing students' academic achievement in automotive braking system compared to the conventional lecture method.

Discussion of the Findings

The findings of this study were discussed in relation to the available literature reviewed based on the research questions and the hypotheses.

Data collected to answer the research question on the pre-test of the two groups, that is, the experimental and control group, have almost the same mean. This finding was in agreement with the findings of Abdullahi (2021) whose research findings indicated that both groups have the same entry level, this in turn proves the equivalence of the two groups at pre-test. From the findings of this study which satisfies the first objective of the study and answers the first research question aimed at avoiding selection bias before commencing the study Arowolo (2018) determining the understanding and the ability level of the students at the beginning of the study, the researcher accepted the null hypothesis which states that there is no significant difference in the pre-test mean of the students taught using lecture method and those taught using VPF in Colleges of Education in North East Nigeria. Since $p = 0.884 > 0.05$, the null hypothesis is accepted,

which means that there is no significant difference in the pre-test mean of the students taught using lecture method and those taught using VPF in Colleges of Education in North East Nigeria.

The study also found that the post-test mean score of the experimental group is higher than the pre-test mean score. The students performed better in the post-test than in the pre-test in the experimental group, which revealed the effect of the treatment. This result is similar to Shatima (2016) who concluded that students achieved higher when taught through web-based instructional strategy as compared to their counterparts. De Sousa, Richter and Nel (2017) affirmed that using various multimedia combinations can address the unique nature of social sciences effectively. Also, Mohammed (2016) revealed that there was significant mean difference between the achievement of pre-test and post-test scores using web-based instructional method since it provides multisensory experience to the students. The hypothesis two which states that there is no significant difference in the post-test and pre-test mean difference of students taught electrical power and machines using web-based multimedia package in Colleges of Education in North East Nigeria was rejected, since the $P = 0.00 < 0.05$. Therefore the null hypothesis is rejected. It can be deduced that there is significant difference in the post-test and pre-test mean between experimental and the control group. This work is similar to the work of Shehu, Abubakar, Mohammed and Saidu (2019) who concluded that there is meaningful difference in favour of the experimental group on the academic achievement in pre-test/post-test. Martin, Budhrani and Wang (2019) also ascertained that web-based multimedia contents maximize the effectiveness of teaching process, just like Dinamika and Pendidikan (2017) concluded that web-based learning was found to be effective in nursing practice, student satisfaction and knowledge.

Findings from the study also revealed that there is difference between the post-test of the experimental (students taught using VPF) and the control (students taught using lecture method). It was found that students in the experimental group performed better in the post-test than the students in the control group. The finding is similar to Agus and Joko (2016) who suggests that an increased level of effort using the tool provided in the online program can statistically improve exam scores. A parallel study by Odo and Odo (2016) agrees that the use of VPF helps students to increase their achievement.

Another finding from the study also revealed that there is a difference between the computed mean gain score of the experimental and control group with the experimental group having a mean gain of 35.9 and a standard deviation of 15.124, while the control group was having a mean gain of 8.27 and a standard deviation of 20.059. In order to determine the significance of the difference, a t-value was found to be 12.971 at 0.05 confidence level. The p-value was found to be 0.000 which is less than the confidence level ($p < 0.05$). This led the researcher to reject the third null hypothesis which states that there is no significant difference in the pre-test and post-test mean gain between experimental and control groups, indicating that there is a significant difference between the mean gain score of students taught VPF in experimental and that of the control group (Ofodile, 2015).

The findings of this study align with the theoretical framework of the Cognitive Theory of Multimedia Learning (Mayer, 2020), which posits that people learn more deeply from words and pictures than from words alone. The Virtual Platform incorporates multimedia elements such as 3D animations, narrated explanations, and interactive simulations, which facilitate deeper cognitive processing and enhance learning outcomes. The findings also support the Constructivist Learning Theory, which emphasizes that learners actively construct knowledge through experiences and reflections. The Virtual Platform provided students with interactive simulations, virtual labs, and problem-solving scenarios where they could construct understanding by virtually assembling, diagnosing, and troubleshooting braking systems.

Furthermore, the findings support the Technology Acceptance Model (TAM), which posits that perceived usefulness and perceived ease of use are primary determinants of technology adoption. The Virtual Platform was designed to be user-friendly and relevant to the curriculum,

which likely contributed to its high acceptance and effectiveness among students.

The findings of this study are consistent with the empirical literature reviewed. Chen and Park (2024) found significant gains in both procedural accuracy and knowledge transfer in the simulation group compared to conventional workshop instruction. Ibrahim (2025) reported comparable findings from a study conducted in Northern Nigerian technical institutions, where a multimedia-based instructional package for automotive electrical systems produced significantly higher post-test achievement scores than the conventional teaching approach. Okafor and Mensah (2025) demonstrated that interactive virtual environments for automotive braking system training need not achieve photographic realism to be effective functional accuracy and pedagogical coherence are the determinative design qualities.

The findings of this study also align with the systematic review and meta-analysis conducted by Okolie, Nwosu, and Mlanga (2024), which found that virtual simulation interventions in TVET produced a mean effect size of $d = 0.68$ on knowledge acquisition outcomes and $d = 0.72$ on practical skill performance outcomes. The review identified the highest effect sizes in studies where the simulation was directly aligned with the specific curriculum objectives of the course in which it was deployed, used in a blended model complementing rather than replacing physical practice, and evaluated using performance-based rather than purely knowledge-based outcome measures. The Virtual Platform developed in this study was directly aligned with the TED 214 curriculum objectives, used in a blended model, and evaluated using the ABSAT, which includes higher-order cognitive items that assess practical application and diagnostic reasoning.

SUMMARY

This study was on the effect of a virtual platform (VPF) on student academic achievement in automotive braking systems in Colleges of Education (Technical) in North East, Nigeria. The virtual platform was restricted to the automotive braking system, basically on the features of hydraulic braking system parts identification, principles of operation, types and steps for repairing the faults in the braking system. The study was also restricted to Federal Colleges of Education (Technical) in the study area.

The study adopted a quasi-experimental research design. The population comprised 986 NCE II (Technical) students from eight NCE (Technical) awarding institutions in the study area. A sample of 270 students (143 experimental and 127 control) from two randomly selected institutions participated in the study. The Automotive Braking System Achievement Test (ABSAT), a 60-item multiple-choice instrument, was used for data collection. The reliability of ABSAT was established using Cronbach Alpha, which yielded a coefficient of 0.833. Data were analysed using mean, standard deviation, and independent and paired sample t-tests at 0.05 level of significance.

CONCLUSION

This study found that the application of VPF in teaching has a positive impact on student achievement, which can attract students and help them to understand abstract concepts. The use of VPF in a lesson also supports a learner-centred approach that is related to Constructivist Learning Theory. Therefore, teachers need to be more creative and innovative in order to attract students in constructing their knowledge by using different approaches.

The study concluded that the Virtual Platform significantly enhanced students' academic achievement in automotive braking systems compared to the conventional lecture method. The experimental group achieved a mean gain of 35.9 compared to 8.27 for the control group, and this difference was statistically significant ($t = 12.971$, $p = 0.000 < 0.05$). The Virtual Platform was effective in improving students' understanding of braking system components, operational principles, diagnostic reasoning, and repair procedures.

RECOMMENDATIONS

1. Lecturers should adopt the use of VPF instead of using conventional methods for teaching and learning since it enhances achievement in Colleges of Education in North-Eastern Nigeria.
2. Policy makers in Colleges of Education should create an enabling environment for lecturers to adopt VPF methods for teaching in Colleges of Education in North-Eastern Nigeria.
3. Conferences, seminars and workshops should be organized by the National Commission for Colleges of Education (NCCE) where curriculum planners and teachers will learn about the application and use of modern teaching techniques in North-Eastern Nigeria.
4. National Commission for Colleges of Education curricular content packages in the minimum standard should be restructured to aid Automobile students' training through VPF.
5. Textbook authors may need to incorporate more student activities and learning experiences into books as experience and student-centered activities play a central role in the learning process.

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