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EFFECT OF COMPUTER ANIMATION ON ACADEMIC ACHIEVEMENT IN DRILLING AND TURNING OPERATIONS AMONG MECHANICAL ENGINEERING CRAFT PRACTICE IN TECHNICAL COLLEGES IN RIVERS STATE

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Abstract
This study examined the effect of computer animation on students' academic achievement in Mechanical Engineering Craft Practice across six machining operations drilling, academic achievement in drilling and turning operations among mechanical engineering craft practice in technical colleges in Rivers State. The study adopted a quasi-experimental non-randomized control group research design. The study participants comprised 128 National Technical Certificate (NTC) II Mechanical Engineering Craft Practice students from three government accredited technical colleges in Rivers State, Nigeria. The experimental group received instruction using computer animation, while the control group was taught with traditional flipped charts. Data was collected through a validated teacher-made multiple-choice test titled Drilling and Turning Operation Test (DATOT). The reliability coefficient of the test was 0.75 obtained through Kuda Richardson-20 Test. Data gathered were analysed using mean and standard deviation for the research questions and analysis of covariance (ANCOVA) for the hypotheses, tested at 0.05 alpha level of significance. Findings revealed that students taught with computer animation performed significantly higher than those taught with flipped charts. These results indicate that computer animation is an effective instructional tool that improves understanding and academic performance in Mechanical Engineering Craft Practice. The study highlights the importance of integrating modern technological tools into technical education to enhance learning outcomes. Based on the findings, it was recommended among others that Government and educational administrators should provide the necessary ICT facilities, multimedia equipment, and animation software in technical colleges to support the

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effective implementation of computer animation as an instructional tool for teaching practical skills. Future research should investigate the long-term effects of animation on skill retention and its applicability in other technical disciplines.

Keywords: Computer Animation, Students' Drilling Operation, Turning Operation, Academic Achievement, Technical and Vocational Education and Training.

INTRODUCTION

The Nigerian government, through its National Policy on Education, has continuously advocated for diversified forms of education to address skill gaps in the nation's workforce. One critical area is technical and vocational education, particularly the establishment of technical colleges aimed at producing competent craftsmen, technologists, and technical educators for various sectors of the economy (Federal Republic of Nigeria, FRN, 2013). Technical colleges are vital for equipping students with practical skills for self-employment and industrial engagement (Mele et al., 2020; Okorafor & Wogu, 2023). Scholars such as Ogunyemi and Agbaje (2018) emphasized that technical colleges serve as institutions where learners acquire job-ready competencies to function either as technicians or as entrepreneurial craft workers. Ochogba and Ordu (2019) further noted that these colleges prepare students for gainful employment or for pursuing higher studies in technology-related disciplines. Mechanical Engineering Craft Practice (MECP), a key trade in these colleges, stands out for its significant contribution to technical manpower development in Nigeria.

The objectives of MECP in technical colleges, as revised by the National Board for Technical Education (NBTE, 2020), include enabling students to convert theoretical learning into practical tasks, handle technical tools proficiently, fabricate and assemble metal components, identify metal properties, and ensure safety practices during operations. Graduates are expected to perform a wide range of machine operations including drilling, turning, milling, shaping, grinding, and fitting. Amaechi et al. (2016) maintained that proficiency in these operations is critical for students aiming to be job-ready in the metalworking industry. However, mastery of these complex procedures often poses challenges due to abstract teaching methods and limited access to physical equipment. In this regard, the integration of animation-based instruction emerges as an innovative pedagogical strategy. Recent studies show that computer animation enhances cognitive engagement and supports deeper understanding of technical content by

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visualizing complex processes (Bakar et al., 2021; Olayinka & Kareem, 2019).

Animation, particularly production plant animation, has been found to enhance comprehension of real-world industrial processes by offering dynamic simulations of mechanical operations and factory layouts (Ibrahim et al., 2018; Okonkwo & Umeh, 2020). Educational animations can bridge the gap between theoretical and practical knowledge by simulating environments that may not be accessible to students due to logistical or financial constraints (Clark & Mayer, 2016). As highlighted by Hattie (2019), visual and interactive instructional techniques improve academic performance by catering to different learning styles. This becomes particularly important in light of the persistent poor performance in Mechanical Engineering Craft Practice recorded in recent National Business and Technical Examinations Board (NABTEB) results. According to NABTEB (2023, 2024), failure rates in MECP have remained above 45%, with specific weaknesses in areas such as forging, foundry, and sheet metal work. These outcomes, as noted by Osagie (2019), are closely linked to outdated and non-inquiry-based teaching methods. The integration of production plant animation into MECP instruction offers a viable solution to these pedagogical gaps by fostering experiential and visual learning environments that can improve students' academic achievement and practical competence.

Statement of Problem

Despite the Nigerian government's continued efforts to promote technical education, the performance of students in technical colleges particularly in Mechanical Engineering Craft Practice remains alarmingly low. Reports from the National Directorate of Employment (NDE, 2024) indicate that many technical college graduates are unable to meet the skill demands of the labor market. Employers increasingly express dissatisfaction with the quality of graduates, often opting to train their own in-house technicians rather than recruit from technical institutions. This trend suggests a significant mismatch between the skills acquired by students and those required in real-world industrial settings, raising concerns about the effectiveness of current teaching strategies and learning environments in technical colleges (GetBundi, 2023).

The National Business and Technical Examinations Board (NABTEB) has repeatedly pointed to ineffective teaching methods as a primary contributor to students' poor performance in technical subjects. The 2021 NABTEB Chief Examiners' report highlights a recurring problem: a lack of practical experience among students, which limits their ability to apply theoretical concepts. This issue is further compounded by the absence of adequate instructional facilities, which hinders the development of hands-on competencies necessary for the workplace (NABTEB, 2024). The resulting skills gap

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prevents students from acquiring the confidence and competence needed to function effectively as mechanical craftsmen, thus weakening their employability and undermining the purpose of vocational education (Peprah, 2019).

This persistent underachievement poses a serious threat to the nation's economic, technological, and educational development. Since technical education is intended to promote self-reliance and industrial growth, there is a pressing need to adopt more engaging and effective instructional approaches. One such promising solution is the integration of animation—specifically, Production Plant Animation—into technical teaching. By simulating real-world mechanical operations, animation has the potential to enhance students' understanding, bridge the theory-practice divide, and ultimately improve academic performance in Mechanical Engineering Craft Practice. This study therefore seeks to investigate the effect of computer animation on academic achievement in drilling and turning operation among Mechanical Engineering Craft Practice students in technical colleges in Rivers State.

Purpose of the Study

The purpose of the study was to investigate the effect of computer animation on students' academic achievement in drilling and turning operation among mechanical engineering craft practice students in Technical Colleges in Rivers State. Specifically, the study sought to:

1. find out the difference in academic achievement in drilling between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State.
2. determine the difference in academic achievement in turning between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State.

Research Questions

The following research questions guided the study

1. What is the difference in academic achievement in drilling between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State?

2. What is the difference in academic achievement in turning between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State?

Hypotheses

The following hypotheses were formulated and were tested at .05 level of significance

1. There is no significant difference in academic achievement in drilling between

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students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State.

2. There is no significant difference in academic achievement in turning between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State.

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METHODOLOGY

The study adopted a quasi-experimental research design. Specifically, the study adopted the pre-test, post-test non-randomized control group design, to investigate the effect of computer animation on academic achievement in drilling and turning operations among Mechanical Engineering Craft Practice students in technical colleges in Rivers State. The design was considered appropriate because intact classes were used without random assignment of students to groups. The study was carried out in three government-owned technical colleges in Rivers State, that offer Mechanical Engineering Craft Practice. The study participants consisted of 128 National Technical Certificate (NTC) II Mechanical Engineering Craft Practice students. Of this number, 70 students constituted the experimental group and were taught drilling and turning operations using computer animation, while 58 students formed the control group and were taught the same content using the conventional flip chart method. The instrument used for data collection was a researcher-developed achievement test titled Drilling and Turning Operation Test (DATOT). The instrument consisted of multiple choice questions containing items on drilling and turning based on the content taught and designed to measure students' academic achievement in drilling and turning operations. The DATOT was subjected to face and content validation by experts in Mechanical Engineering Craft Practice and educational measurement and evaluation to ensure its suitability for the study. Prior to the treatment, the DATOT was administered to both the experimental and control groups as a pre-test to determine their initial achievement levels. The experimental group was then exposed to instruction using computer animation, while the control group received instruction through the traditional flip chart method. At the end of the treatment period, the same instrument was reshuffled and administered as a post-test to both groups to measure the achievement gained after the instructional treatments. The data collected from the pre-test and post-test administrations were analyzed using mean and standard deviation to answer the research questions, while Analysis of Covariance (ANCOVA), using the pre-test scores as covariates, was employed to test the null hypotheses at the 0.05 level of significance.

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Results

Research Question 1: What is the difference in academic achievement in drilling operation between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State?

Table 1: Mean Scores of Students Taught Drilling Operation

Group	N	Pre-test		Post-test		Mean Difference	Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD		
Experimental	70	15.60	3.14	42.07	2.98	26.47	16.47
Control	58	16.50	3.40	26.50	3.43	10.00	

Table 1 shows the pre-test and post-test mean score of students in drilling operation skills for both treatment and control groups. Result shows that the students in the experimental group had a pre-test mean score of 15.60 with a standard deviation of 3.14 and a post-test mean score of 42.07 with a SD of 2.98. The difference between the pre-test and post-test mean for the experiment group was 26.46. The result shows that the control group had a pre-test mean score 16.50 with a standard deviation of 3.40 and a post-test mean score of 26.50 and SD of 3.43. The difference between the pre-test and post-test mean for the experiment group was 10.00. This shows that the mean score for the experimental group was higher than the control group by a mean difference of 16.47. This indicates that those exposed to computer animation performed better. This result shows that both the computer animation and traditional flip chart enhanced academic achievement in drilling. However, the computer animation enhanced academic achievement in drilling operation more.

Research Question 2: What is the difference in academic achievement in turning operation between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State?

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Table 2: Mean Scores of Students Taught Turning Operation

Group	Pre-test			Post-test		Mean Difference	Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD		
Experimental	70	14.21	3.49	41.85	4.48	27.64	17.89
Control	58	15.00	3.55	24.75	3.99	9.75	

Table 2 shows the pre-test and post-test mean score of students in turning operation skills for both treatment and control groups. Result shows that the students in the experimental group had a pre-test mean score of 14.21 with a standard deviation of 3.49 and a post-test mean score of 41.85 with a SD of 4.48. The difference between the pre-test and post-test mean for the experiment group was 27.64. The result shows that the control group had a pre-test mean score 15.00 with a standard deviation of 3.55 and a post-test mean score of 24.75 and SD of 3.99. The difference between the pre-test and post-test mean for the experiment group was 9.75. This shows that the mean score for the experimental group was higher than the control group by a mean difference of 17.89. This indicates that those exposed to computer animation performed better. This result shows that both the computer animation and traditional flip chart enhanced academic achievement in drilling. However, the computer animation enhanced academic achievement in drilling operation more.

Hypothesis 1: There is no significant difference in academic achievement in drilling between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State.

Table 3: ANCOVA: Effect of Computer Animation on achievement in Drilling operation

Source	*Sum of Squares*	*Df*	*Mean Square*	*F*	*p-value*	*Decision*
Corrected Model	1887.708[a]	2	943.854	111.266	.000	
Intercept	6208.825	1	6208.825	731.927	.000	
Pretest	21.025	1	21.025	2.479	.120	
Group	1775.939	1	1775.939	209.356	.000	Rejected
Error	653.180	124	8.483			
Total	60699.000	125				
Corrected Total	2540.888	123				

a. R Squared = .743 (Adjusted R Squared = .736)

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Result in Table 3 shows the test of significance for difference in academic achievement in drilling between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State. As shown F (1, 124) = 209.356, $p < 0.05$. Based on this, the hypothesis was rejected. This implies that there was no significant difference in academic achievement in drilling between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State.

Hypothesis 2: There is no significant difference in academic achievement in turning between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State.

Table 4: ANCOVA: Effect of Computer Animation on achievement in Turning operation

Source	*Sum of Squares*	*Df*	*Mean Square*	*F*	*p-value*	*Decision*
Corrected Model	304.743[a]	2	152.372	5.109	.008	
Intercept	6508.983	1	6508.983	218.228	.000	
Pretest	6.918	1	6.918	.232	.631	
Group	231.035	1	231.035	7.746	.007	Rejected
Error	2296.644	124	29.827			
Total	61843.000	125				
Corrected Total	2601.388	123				

a. R Squared = .117 (Adjusted R Squared = .094)

Result in Table 4 shows the test of significance for difference in academic achievement in drilling between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State. As shown F (1, 124) = 7.746, $p < 0.05$. Based on this, the hypothesis was rejected. This implies that there was no significant difference in academic achievement in drilling between students taught using computer animation and students taught using traditional flip chart in Technical Colleges in Rivers State.

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Discussion of Findings

The findings for research question 1 revealed that students taught drilling operations using computer animation performed significantly higher than their counterparts taught with traditional flipped charts. The experimental group taught using computer animation had a higher mean score than the control group taught using traditional flip charts. The results showed that both the experimental and control groups had their academic achievement in drilling improved after the exposure. However, the academic achievement of the experimental group was higher. This implies that the two methods are useful in enhancing students' academic achievement in drilling operation. However, the computer animation was better. The better academic achievement of the experimental group taught using computer animation may be because animation made drilling operations easier to understand than traditional flip charts. Computer animation allowed students to see the movement of machine parts, drilling procedures, and safety practices in a real-life and step-by-step manner, which could have led to improvement in students' understanding of drilling operation. The combination of pictures, motion, and explanations also helped students to remember the lessons better and kept them more interested and motivated during learning. In addition, animation could have given students the opportunity to repeatedly watch and understand difficult procedures which could have helped them connect theory with practical workshop activities. These advantages could have likely made learning more effective and contributed to the higher achievement of students taught with computer animation compared to those taught with traditional flip charts.

These results support previous studies that have found visual-based instructional strategies, such as animations and simulations, to enhance students' comprehension and retention of complex technical subjects (Mayer, 2009; Ibrahim et al., 2012). Animations provide dynamic and interactive visualizations that simplify abstract concepts, thereby improving learner engagement and cognitive processing (Clark & Mayer, 2016). Moreover, the findings align with the constructivist learning theory, which suggests that learners gain knowledge more effectively through active engagement and meaningful interaction with learning materials (Jonassen, 1999). The use of animations likely offered a more immersive and participatory learning experience than static flipped charts, contributing to the superior performance of the treatment group. In the context of technical education in developing regions like Rivers State, Nigeria, integrating digital tools such as PPA can help close the gap between theoretical knowledge and practical skills. This supports the assertions of Aina and Akinbobola (2014), who highlighted the importance of multimedia resources in improving the quality and delivery of vocational and technical education.

The findings for research question 2 revealed that students taught turning operations using computer animation

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performed significantly higher than their counterparts taught with traditional flipped charts. The experimental group taught using computer animation had a higher mean score than the control group taught using traditional flip charts. The results showed that both the experimental and control groups had their academic achievement in turning improved after the exposure. However, the academic achievement of the experimental group was higher. This implies that the two methods are useful in enhancing students' academic achievement in turning operation. However, the computer animation was better. The higher academic achievement of students taught turning operations using computer animation may be attributed to the ability of animation to clearly demonstrate the sequence and movement involved in turning processes. Through animation, students might have found it easy to observe tool positioning, workpiece rotation, cutting actions and other operational details that may be difficult to explain using static flip charts. This could have likely enhanced their understanding of the concepts and procedures involved in turning operations. Computer animation may also have increased students' attention and interest in the lesson which could have resulted in making learning more engaging and meaningful. Furthermore, the realistic presentation of turning activities could have enabled students to visualize practical workshop experiences, thereby improving comprehension and retention of the instructional content. Although both instructional methods improved students' achievement, the interactive and visual nature of computer animation appears to have provided a more effective learning experience, resulting in the superior performance of the experimental group.

This outcome aligns with prior research demonstrating the effectiveness of animation and visual-based tools in enhancing learner comprehension, particularly in technical and vocational education (Mayer, 2009; Ibrahim et al., 2012). Animated instruction allows visualization of dynamic mechanical processes, facilitating deeper understanding and better retention of abstract concepts (Clark & Mayer, 2016). Furthermore, the effectiveness of PPA is supported by the cognitive theory of multimedia learning, which emphasizes improved understanding when verbal and visual content are combined (Mayer, 2009). Compared to static images or text, animations effectively demonstrate processes like tool movement, workpiece rotation, and machine coordination—critical elements in turning operations. This finding also reinforces the constructivist learning theory, which advocates for interactive, student-centered learning environments where learners actively construct knowledge (Jonassen, 1999). By engaging students with digital content such as animations, the gap between theoretical instruction and practical application in vocational education is bridged. In the context of Nigeria's technical education system, especially in Rivers State, these results highlight the importance of integrating modern technological tools to improve teaching and learning outcomes, consistent with the observations of Aina and Akinbobola (2014)

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on the value of multimedia in technical education.

Conclusion

Based on the findings of the study, it was concluded that both computer animation and traditional flip charts were effective instructional methods for improving students' academic achievement in drilling and turning operations in Mechanical Engineering Craft Practice in technical colleges in Rivers State. However, computer animation was found to be more effective than traditional flip charts in enhancing students' achievement in both drilling and turning operations. The higher academic achievement of students exposed to computer animation suggests that the use of animated instructional materials enhances understanding of practical processes, promotes learners' interest and engagement, and facilitates better retention of instructional content. Therefore, the integration of computer animation into the teaching of practical mechanical engineering concepts can significantly improve students' learning outcomes and contribute to more effective technical and vocational education and training in technical colleges.

Limitations and Future Study

The study was limited to only two Mechanical Engineering Craft Practice topics including drilling and turning operations. Based on this, the findings may not be generalized to other machine operations such as milling, shaping, fitting, welding etc. A similar study is suggested on these operations to determine the effectiveness of computer animation across different practical skill areas. The study was conducted using NTC II Mechanical Engineering Craft Practice students from only three government technical colleges in Rivers State. Consequently, the findings may not fully represent students in private technical colleges or technical colleges in other states of Nigeria. Consequently, future studies could consider private technical colleges in Rivers State as well as other states. The present study focused primarily on academic achievement in drilling and turning operation. Future researchers could investigate the effect of computer animation on students' practical skill acquisition, retention, and interest in Mechanical Engineering Craft Practice.

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