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Development And Validation Of An AI Enhanced Motion Graphic Instructional Package For Teaching Woodworking Machine- Tools In Colleges Of Education In North-West, Nigeria.

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Abstract
The study aimed to develop and validate an AI -enhanced digital motion graphic instructional package (DMGIP) for teaching Woodworking machine – tools in colleges of Education in North-West, Nigeria. The Research and Development (R&D) Methodology was employed utilizing the ADDIE Instructional Design Model. Also, the Quasi - Experimental procedure was used during the Implementation and Evaluation staged of the ADDIE design model in determining the effectiveness of the developed DMGIP on students Cognitive Achievement. The validation process yielded high reliability coefficient for the instruments used, with, with computed values of .907, .878, .873, .967 and .983 obtained. The study was guided by five Research Questions and three Null Hypotheses which were tested at 0.05 level of significance and, findings revealed a significant difference in the Mean Achievement scores of students taught with the AI -enhanced digital motion graphic instructional package and those taught with conventional method. The result indicated that the developed DMGIP was effective was effective in enhancing students' cognitive achievement and interest in woodworking Machine – tools. Furthermore, the three null hypotheses were accepted. Based on these findings, it was recommended that the National Commission for Colleges of Education and Woodworking machine tools Lecturers should use the AI – enhanced Digital Motion Graphic Instructional Package in Woodworking machine - tools.

Key Words: *AI -Enhanced Digital Motion Graphic, Woodworking Machine -Tools, Colleges of Education*

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I. Introduction:

Artificial Intelligence (AI) is transforming the educational sector by providing innovative solutions to enhance teaching and learning processes. Findings from literature in Cognitive Psychology has provided empirical facts which largely supported the claim that graphics benefits learning, with most studies indicating that graphics improves memory for the illustrated information and comprehension of the situation described in the text. The use of digital technology involves a deliberate effort aimed at ensuring that learning is interactive, accessible and effective. According to Scagnoli (2025) noted that traditional campus-based teaching and learning is making a shift to a new way of education highlighting the move from "place method" to blended, more interactive, technology rich environments. This has given rise to the deployment of digital 3-Dimensional technology and other instructional multimedia technologies which have the capacity to create high quality learning environment especially for students through the use of different computer applications like computer animation, Algorithms and techniques, plausible motion simulation, mobile control kinematics, robotics, behavioural animation, human figure animation and character animation and so on. Furthermore, recent growth in the field of digital technology has brought in the use of digital realities such as Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) and Extended Reality (FR) which are platforms that essentially combines real and virtual worlds, real time interaction, and accurate 3D registration of virtual and real objects to enhance learning. Artificial Intelligence can be used to create tutorials and interactive virtual assistants, systems that can answer students' questions, provide additional explanations, and guide students in real-time through the learning process (Mircea, 2023).

Despite all these arrays of benefits as supported by most empirical studies teachers are yet to fully adopt its use. According to Brendon (2018), while teachers are expected to integrate technology into the classroom, the reality can be very different. Furthermore, studies as shown in literature indicate that prevailing teaching strategies predominantly employed by most teachers of woodworking technology in Nigeria are largely teacher-cantered, involving mostly description of abstract phenomenon. Khan and Ali (2023) argued that teacher centred pedagogy

is often seen as narrow, teacher – dominated, and outdated, and because it is context – based it can inhibit students creative thinking.

The Philosophy and objectives of the Nigeria Certificate in Education (Technical) programme as captured in the NCE minimum standards for Vocational and Technical Education essentially seeks to provide technical teachers with the intellectual and professional background adequate for teaching technical subjects and to make them adoptable to any changing situation in technological development not only in the country but also in the world at large (NCCE minimum standard, 2020 Edition). Similarly, Machine woodworking with the code TED 212; it is a two (2) credit course offered by all 200 level NCE (Technical Education) students. The specific objectives of the course as stipulated in the NCCE minimum standard is basically to introduce students to various types of Woodworking Machines - tools as well as equip them with both their sequence of operations and their principles of operation. It is against these backdrops that the study sought to leverage on innovative solution provided by AI to develop and validate an AI enhanced Digital Motion Graphic Instructional Package for teaching Woodworking Machine - Tools in Colleges of Education in North – West, Nigeria.

Problem Statement/Justification:

The main objective of the Nigeria Certificate in Education (Technical) programme aims to produce competent technical teachers, but the lack of learning materials as opined by Kapur (2022) negatively affects student's by hindering academic performance, reducing their ability to grasp concepts, and stifling independent learning. This can lead to lower exam scores, lack of motivation, and difficulty developing critical skills, which ultimately lowers the quality of education received. This study proposes the development of a digital motion graphic instructional package (DMGIP) to enhance the teaching of woodworking machine tools, fostering conceptual understanding and engagements. Research has shown that technology integration can foster a high – quality learning environment, leading to increased efficiency and improved academic outcomes (Nitza & Roman, 2022). It is anticipated that the instructional package will facilitate conceptual understanding of the basic working principles of woodworking machine tools and thereby engender students' interest and motivation to study woodworking technology. This forms the basis for this study.

Objectives of the Study

The aim of the study is to develop and validate a digital 3D motion graphic instructional package to be used in the teaching of woodworking machine tools. By leveraging digital technology, this study sought to revolutionize the teaching and learning of woodworking machine tools, making it more engaging, interactive and effective.

The study specifically sought to:

1. Develop the digital 3D motion graphic instructional package based on the identified woodworking machines tools and the appropriate features determined in line with the ADDIE model.
2. Evaluate the suitability of the DMGIP for teaching woodworking Machine tools in Colleges of Education in Nigeria.
3. Investigate the effect of the DMGIP on students' cognitive achievement on woodworking machine tools.

Research Questions:

1. What are the woodworking machine tools most suitable for inclusion in the digital motion graphic instructional package (DMGIP) developed based on the ADDIE model for teaching woodworking machine tool concepts in Colleges of Education in North -West Nigeria?
2. How suitable is the DMGIP for teaching woodworking machine tools in Colleges of Education in North -West Nigeria?
3. What are the differences in cognitive achievement between students taught woodworking machine tools using DMGIP method and those taught using conventional methods in Colleges of Education in North -West Nigeria?

Hypotheses

The following null hypotheses were formulated to guide the study and were tested at 0.05 level of significant

$H0_1$: There is no significant difference between the mean achievement scores of students in experimental and control group at the pre-test.

$H0_2$: There is no significant difference between the mean achievement scores of students in experimental group in the pre-test and post-test.

$H0_3$: There is no significant difference between the mean cognitive achievement scores of Experimental and Control groups in the post-test.

Theoretical framework

This study is grounded in the Cognitive Theory of Multimedia Learning (CTML). The theory proposed by Mayer and Moreno (2020) posits that learners process multimedia information (Words, Pictures, and Audio) dynamically, integrating new information with prior knowledge. The theory emphasizes the importance of capturing learners' interest, selecting relevant information and managing working memory.

Key Assumptions:

I. Dual channels: Separate auditory and visual channels process information
II. Limited capacity: Each channel has finite processing capacity
III. Active learning: Learner's filter, select, organize, and integrate information based on prior knowledge

Application to the study:

The CTML framework informs the development of the digital 3D motion graphic instructional package (DMGIP), which combines visual and auditory elements to enhance learning. By leveraging multimedia principles, the DMGIP aims to promote deeper learning, improved cognitive achievement, and increase learners' engagement.

II. Methodology:

A research design according Shana (2022) is a strategy for answering your research questions using empirical data and also allows the researcher to test cause and effect relationships. This study employed a quasi-experimental research design, specifically the pre-test and post -test non-equivalent control group design. The design was chosen due to the use of existing classrooms, making random assignment impractical. According to Capili and Anastasi (2024), quasi –experimental design can be used when it is not possible for the researcher to randomly sample the subjects and assign them to treatment groups without disrupting the academic program of the school involved in the study.

Study Area:

The actual study was conducted in North West Nigeria covering all the public Colleges of Education in the zone. The North West geopolitical zone consists of seven (7) states namely: Kaduna, Kano, Jigawa, Katsina, Zamfara, Sokoto and Kebbi states. The study was limited to the North West Geo-Political Zone of Nigeria. The northwest zone occupies a land mass of about 214,395km, lies between longitude $12^{O}10'$ North and latitude $6^{O}15'$ East. The region has a population of about 49 million people, around 23% of the total population of the country.

Population:

The population for the study consisted of the entire NCE 2 students (intact groups) offering Woodwork Technology in all the **12** public Colleges of Education in North- West, Nigeria. Four **(4)** Machine Woodwork course lecturers were involved as the resource persons for both the control and experimental groups. Similarly, 10 Machine Woodworking (TED 212) lecturers serve as respondents, 5 experts in Woodwork Technology/ Instructional Technology and 3 Computer Graphic Animation software development experts were involved as validators. The treatment was administered to both the experimental group and the control group using the developed instructional package and conventional method.

Sampling Procedures:

Four Colleges of Education were randomly selected for the study, with two serving as the experimental group and the other two as the control group.

Treatment:

The experimental group was taught using the DMGIP for 3 hours per week over 5 weeks, while the control group received conventional teaching for the same duration.

Data for the study was collected by the researcher through the assistance of four Machine woodworking teachers who served as research assistants. The researcher was assisted by two Machine woodworking teachers in pilot testing the DMGIP instrument for a period of four (4) weeks during the first semester in teaching Machine tools.

Data collected:

Data was collected through:

I. Pre – test and posttest assessments
II. DMGIP suitability Questionnaire

Data Analysis:
Data were analysed using
I. Mean, standard deviation.
II. The independent sample t-test was used to test the hypotheses
III. Lavene's test for equality of variance was used to determine the difference between sample variances of the two groups. According to Berg (2023), the Lavene's test can be used as a precursor for other tests such as the independent sample t-test and ANOVA.

III. Results Of The Study

The results of the data analysed were presented, interpreted and discussed. The presentation follows the order of the research questions.

Research Question 1

What are the woodworking machine tools most suitable for inclusion in the digital motion graphic instructional package (DMGIP) developed based on the ADDIE model for teaching woodworking machine tool concepts in Colleges of Education in North -West Nigeria?

Based on the research findings, nine woodworking machine tools were considered suitable for inclusion in the DMGIP for teaching machine tools concepts in Colleges of Education. These machine tools had mean ratings above 3.50, indicating a high level of agreement among respondents about their suitability. The mean ratings ranged from 5.00 to 1,67, with the nine suitable machines rated above the accepted limit. This suggests that these machine tools are essential for inclusion in the DMGIP to provide students with a comprehensive virtual learning experience, allowing them to explore and interact with machine tools in a simulated environment.

Table 1: Mean responses of Woodworking Lecturers on Task and Content Analysis for inclusion in the DMGIP developed for teaching Machine tools **N= 6**

S/N		N	Mean	Std. Deviation	
		Statistic	Statistic	Statistic	Decision
1	Circular Sawing	6	5.00	.000	Suitable
2	Surface Planer (Jointer)	6	4.83	.408	Suitable
3	Panel Planer	6	1.83	.408	Not Suitable
4	Band Saw	6	4.83	.408	Suitable
5	Radial Arm (Cross cutting)	6	4.33	.816	Suitable
6	Spraying Machine (Compressor)	6	3.53	.516	Suitable
7	Sanding Machine (Disc Sander)	6	3.50	.837	Suitable
8	Mortising Machine	6	1.83	.408	Not Suitable
9	Wood Drill Press	6	1.67	.816	Not Suitable
10	Wood Pressing Machine	6	2.00	.894	Not Suitable
11	Glue Spreading Machine	6	1.17	.408	Not Suitable
12	Thicknessing Machine	6	3.83	.408	Suitable
13	Wood Lathe	6	4.33	.516	Suitable
14	Jig Sawing Machine	6	4.17	.408	Suitable
	Valid N (listwise)	6			

Source: Field survey 2025

Research Question 2

How suitable is the DMGIP for teaching woodworking machine tools in Colleges of Education in North -West Nigeria?

Answer to research question 2 provided in Tables 2; data in table shows ratings of the suitability of the computer graphic animation courseware for teaching Machine woodworking in Colleges of Education in Nigeria. All the twenty (20) items were rated ranging between 5.00 and 4.60 Mean value. This indicates that computer graphic animation was considered appropriate and suitable by all the ten Machine woodworking teachers in Colleges of Education that served as respondents.

Table 2: Mean responses of Lecturers (Wood Work Technology / Educational Technology) on the Suitability of the DMGIP in Teaching Machine Tools

S/N		N	Mean	Std. Deviation	
		Statistic	Statistic	Statistic	Decision
1	The number of Woodworking Machines included in the animation courseware is in line with the NCCE minimum standard	10	4.80	.422	Agree
2	The design of the Machines is a true suitable replica of the actual Machines	10	4.90	.316	Agree

3	The features used in the development of the animation Courseware is appropriate	10	4.70	.483	Agree
4	The animation courseware allows students to work at their own pace	10	4.60	.516	Agree
5	The presentation of lessons using the animation courseware to stimulates recall	10	4.90	.316	Agree
6	The presentation of lessons using the animation courseware is captivating	10	4.90	.316	Agree
7	The presentation of lessons using the animation courseware is exciting	10	5.00	.000	Agree
8	The presentation of lessons using the animation courseware is interesting	10	5.00	.000	Agree
9	The presentation of lessons using the animation courseware is motivating	10	5.00	.000	Agree
10	The content of the animation courseware meets the NCCE minimum standard	10	5.00	.000	Agree
11	The animation courseware can be used on other multimedia and e-learning platforms	10	5.00	.000	Agree
12	The content of the animation courseware can be modified and enhanced to suite different target groups	10	5.00	.000	Agree
13	The animation courseware package is structured to be replayed or forwarded	10	4.80	.422	Agree
14	The content of the animation courseware package is self-explanatory	10	5.00	.000	Agree
15	The animation courseware package is clear and of good quality	10	5.00	.000	Agree
16	The animation courseware package is not difficult to operate	10	4.70	.483	Agree
17	The pedagogical aspect of the animation courseware is appropriate and suitable	10	5.00	.000	Agree
18	The technical /mechanical component of the animation courseware is appropriate and suitable for teaching and learning	10	4.70	.483	Agree
19	The use of the animation courseware encourages teacher/students' interaction and participation	10	5.00	.000	Agree
20	The content of the animation courseware is sufficient to achieve stated objectives of the course	10	5.00	.000	Agree
	Valid N (listwise)	10			

Source: Field survey 2025

Research Question 3

What are the differences in cognitive achievement between students taught woodworking machine tools using DMGIP method and those taught using conventional methods in Colleges of Education in North -West Nigeria?

The findings revealed significant improvement in cognitive achievement among students taught with Digital Motion Graphic instructional package (DMGIP) compared to those taught with conventional method.
Experimental Group:
Pre-test score = 5% - 55% (Mean = 57%)
Posttest = 50% - 80% (Mean = 90%)

Control Group:
Pre -test = 5% - 35% - 35% (Mean = 22.5%)
Post-test = 40% - 65% (Mean = 52.5%)

The study employed t -test and paired mean statistical correlation analysis to determine the effectiveness of DMGIP. The result showed:

- Experimental group: Mean gain = 36.48
- Control group: Mean gain = 11.37

Findings indicates that DMGIP had a positive effect on students' cognitive achievement in woodworking machine tools, with significant difference in mean score between the experimental and control groups.

Table 3: Mean, standard Deviation, of the Effect of DMGIP on Students' Cognitive Achievements.

Group Statistics

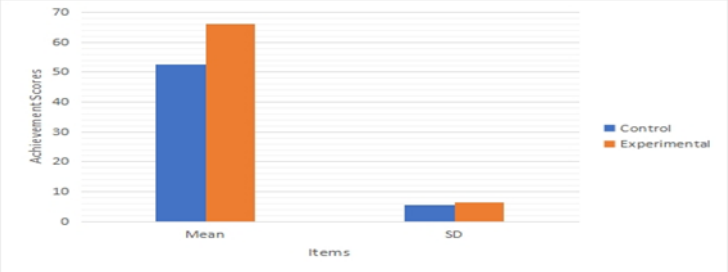
Pre- test and post-tests (within-groups)

Group	Pre-test		Post-test		
	Mean	SD	Mean	SD	Mean gain
Control Group	21.20	6.846	52.57	5.419	11.37

Experimental Group	29.56	11.196	66.04	6.259	36.48

Source: Field survey 2023

The result of test performance of the effectiveness of the developed DMGIP on student's cognitive achievement among the two groups in posttest is further presented in the Bar Chart, another form of descriptive analysis in Fig 1



Test of Hypotheses

Hypothesis One

H0$_1$: There is no significant difference between the mean achievement scores of students in experimental and control group at the pre-test.

The Levene's test for equality of variance revealed a significant difference in variance between the experimental and control groups pre-test scores ($p=0.001$) < 0.05. This indicates that the assumption of equal variances is not met, suggesting potential difference in group dispersion. According to Berg (2023) if the p –value for the Levene test is greater than .05, then the variances are not significantly different from each other's. Independent sample T -test results (table 4) showed a significant difference in cognitive achievement scores between the experimental group (M = 29.56; SD = 11.20; and control group (M = 21.20, SD = 6.34). The t -test statistics (t = -4.642, p < 0.0001) and effect size (Cohen's d = 4.6) indicates a large practically significant difference between groups. Since the p -value (0.0001) is less than the typical significance level ((P <0.05), we Reject the null hypothesis.

The result provides evidence for the effectiveness of the intervention, with the experimental group showing significantly higher cognitive achievement scores than the control group. The large effect size (d = 4.6) suggests a substantial practical difference between groups, indicating that the intervention had a meaningful impact on student outcomes.

Table 4: Levene's Test for Equality of Variance

Levene's Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Cognitive achievement	Equal variances assumed	8.851	.003	-4.642	135	.0001	-8.36479	1.80182	-11.92823	-4.80135
	Equal variances not assumed			-5.403	130.063	.000	-8.36479	1.54808	-11.42746	-5.30212

Source: Field survey 2025

Hypothesis Two

H0$_2$: There is no significant difference between the mean achievement scores of students in experimental group in the pre-test and post-test.

Data presented in Table 5 shows the paired sample statistics of pre - test and post test results of the experimental group. The paired sample t – test also known as paired T test is used when each subject has a pair of measurements, such as a pre –test and post test score. According to Frost (2024) the test is used to determine whether there is a significant improvement between the tests.

The paired sample statistics showed pre-test scores M = 29.56 and SD = 11.20 and posttest scores: M =66.04 and SD = 6.289. The paired t -test results showed p =value <0.0001 (highly significant). Effect size – Cohen d = 4.53 (Very large effect size). The paired sample t =test revealed a statistically significant difference

between pre -test and posttest scores, indicating a substantial practical difference. The large effect size (d = 4.53) suggests that the intervention had a profound impact. The result suggests rejecting the null hypothesis, indicating a significant improvement from the pre-test to posttest

Table 5: Paired Sample t–Test

Group	Pre-test		Post-test		t	d.f	p-value
	Mean	SD	Mean	SD			
Experimental Group	29.56	11.196	66.04	6.259	-27.117	90	.0001*

Source: Field survey 2025

Hypothesis Three

H0$_3$: There is no significant difference between the mean cognitive achievement scores of Experimental and Control groups in the post-test.

Levene's test for equality of variance test revealed that variances are equal across group ($p = 0.618 > 0.05$), indicating homogeneity of variance. This meets the assumption for conducting a t -test.

The test result analysis showed a statistically significant difference between the group ($p < 0.0001$). The Mean difference (- 13.47874) is significant, providing strong evidence for the effectiveness of the intervention. Cohen's d -value (-12.434) indicates a very large practical difference between the groups, suggesting that the intervention had a substantial impact.

The results demonstrate a highly significant difference between the two groups with the intervention group showing a substantial improvement. The large effect size and significant p = value provide strong evidence for the effectiveness of the intervention.

Table 6: Levene's Test for Equality of Variance / Independent Samples Test for Hypothesis 3

Levene's Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Diff	Std. Error Diff	Lower	Upper
Cognitive achievement	Equal variances assumed	.249	.618	-12.434	135	0.001	-13.47874	1.08402	-15.62259	-11.33489
	Equal variances not assumed			-13.038	102.791	0.001	-13.47874	1.03384	-15.52916	-11.42832

Source: Field survey 2025

IV. Discussion Of Findings:

This study investigated the effectiveness of Digital Motion Graphic Instructional Package on students' cognitive achievement in woodworking machine tools. The results of the hypotheses testing revealed significant findings that are discussed below:

The result of the study has implication for teaching and learning in woodworking machine tools. The use of DMGIP can be an effective way to enhance student engagement, motivation and achievement in technical education. Teachers and instructors can incorporate DMGIP into their instructional practices to provide students with interactive and engaging learning experiences.

V. Conclusion:

The study demonstrates that Digital Motion Graphic Instructional Package (DMGIP) is an effective instructional tool for teaching woodworking machine tools in Colleges of Education. By enhancing students' engagement and understanding, the DMGIP has the potential to revolutionize the teaching – learning process.

Recommendations

To leverage the benefits of DMGIP, the study recommends:

I. Adopting instructional design model: Utilize models like ADDIE to develop effective instructional materials.
II. Integrating Technology: Incorporating electronic learning platforms like DMGIP into machine woodworking education.
III. Promoting virtual learning: Encouraging the use of virtual learning platforms and ICT in education.

IV. Curriculum revision: Update curricula to incorporate ICT and digital literacy.
V. Capacity building: Train educators in creating engaging digital contents using motion graphics, animation and other technologies.
VI. Policy Implementation: Make ICT integration mandatory in Colleges of Education to enhance teaching and learning.

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