Available online at https://asric.africa/engineering-sciences
ASRIC Journal on Engineering Sciences Vol.6(1)(2025) 424-436

Improving Students' Performance in Carpentry and Joinery Through Artificial Intelligence Multimodal Learning Materials Utilization at Crafts Development Centres in South-South Nigeria.

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Received 14 July 2025; revised 18 August 2025; accepted 30 October 2025

Abstract

This study was necessitated due to poor performance of students in carpentry and joinery at crafts development centers in South-South Nigeria. The study was significant; owning to the fact that, in recent times, carpentry and joinery craft has become one of the lucrative careers. The study adopted Descriptive Survey and Quasi-Experimental designs. Six research questions and six null hypotheses guided the study. The population of the study was 346, which comprised 316 Level II students and 30 teachers in carpentry and joinery craft at Crafts Development Centres in South-South States of Nigeria. The instruments for data collection were performance test and questionnaire; which were validated by three experts. The reliability coefficient of performance test and the questionnaire were 0.78 and 0.76 respectively. Mean, Standard Deviation, z-test and ANCOVA were used for data analysis. The findings of the study revealed that, the use of Multimodal Learning Materials powered by Artificial Intelligence (AI) improved students' performance, retention, interest, engagement, teacher-students' interaction and student-student interaction. The study among others recommended that teachers should be trained on the use of AI Multimodal Learning Materials in order to enhance students' performance in carpentry and joinery craft.

Keywords: AI Multimodal Learning Materials, carpentry, joinery, crafts development centers, performance.

Introduction

The most critical factor in the sustainable development matrix of any nation is the availability of adequately qualified skilled labour. In realization of this fact, most state government in Nigeria established craft development centres. Crafts Development Centres are hubs for vocational training, cultural preservation, and economic empowerment.

One of the crafts taught in these centres is carpentry and joinery. The training of students in this trade is facilitated and achieved through the use of instructional materials. An instructional material is a well-developed teaching aid or kit that facilitates teaching and learning. A good instructional material concretizes learning and improves students' performance (Anyanwu & Iwuamadi, 2015 cited in Jones, 2022). One example of instructional material used in teaching and learning in crafts development centres is flip chart. A flip chart is a large pad of paper usually mounted on an easel or stand for presentations. It is often used to display information, ideas, or key points for in a visual format. However, an instructional material is effective when it has element of flexibility and adaptability. Flexibility and adaptability in instructional material refer to the ability of an instructional material to

accommodate different learning styles, needs, and abilities of students. An example of a flexible and adaptive instructional material in recent time is the artificial intelligence multimodal learning material (Al-Taai, 2021).

Artificial Intelligence (AI) Multimodal Learning Materials according to Ryan (2023) could be AI-generated, AI-curated and AI-powered. AI-generated Multimodal Learning Materials are learning resources that are created by AI system. This means that the AI system is responsible for generating the content from scratch. In the case of AI-curated Multimodal Learning Materials, AI is used to select, organize or filter existing content to form a resource. On the other hand, AI-powered Multimodal Learning Materials refer to educational resources that utilize AI technology to integrate multiple modes of learning that appear in various formats, such as text, images, videos, and audio. These materials cater different learning styles which could lead to better understanding and retention The materials could also be used to enhance students' performance, interest, engagement, interaction with teachers and among students. In the context of this study, AI-powered Multimodal Learning Materials was examined. This learning materials can provide a tailored learning experience, addressing individual learners' needs and abilities (Dorgu, 2021).

The absence of AI multimodal learning materials according to Uduafemhe and Raymond (2019 cited in Dan, 2023), leads to inadequate skills acquisition, wasted time and resources, frustration, and demotivation and under performance. This scenario is playing out in Carpentry and Joinery programme in Craft Development Centres in South-South Nigeria due to the absence of multimodal learning materials.

The growing concern about low performance of students in carpentry and joinery trade in crafts development centers across Nigeria need not be ignored. This is because construction industries are in dire need of competent skilled carpenters and joiners who will be part of their workforce. However, many carpenters and joiners that have graduated from these centres lack the necessary skills and knowledge to excel in these trades. As a result, the industries faces a shortage of skilled workers, leading to a gap in the number of trained carpenters and joiners to meet the demand (Dobreva-Dragostinova, 2023). The situation has led to high rate of unemployment or underemployment among young carpenters and joiners that have graduated from those centres. How can the use of multimodal learning materials save this situation? The research on improving the performance of students in carpentry and joinery through multimodal learning materials sought to find the answer.

The research specifically determined:

1. effect of multimodal learning materials on students' performance
2. effect of multimodal learning materials on students' retention
3. effect of multimodal learning materials on students' interest
4. effect of multimodal learning materials on teacher-students' interaction
5. effect of multimodal learning materials on student-student' interaction
6. effect of multimodal learning materials on engagement

The following research questions guided the study.

1. What is the effect of AI multimodal learning materials on students' academic performance?
2. What is the effect of AI multimodal learning materials on students' retention?
3. What extent of effect does the use of AI multimodal learning materials have on students' interest?
4. What extent of effect does the use of AI multimodal learning materials have on teacher-students' interaction?
5. What extent of effect does the use of AI multimodal learning materials have on student-student' interaction?
6. What extent of effect does the use of AI multimodal learning materials have on engagement?

The following hypotheses were formulated and tested at 0.05 level of significance.

Ho_1: There is no significant difference between the mean scores of students taught carpentry and joinery with AI multimodal learning materials and students taught with flip chart.

Ho_2: There is no significant difference between the mean retention scores of students taught carpentry and joinery with AI multimodal learning materials and students taught with flip charts.

Ho_3: There is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on students' interest in carpentry and joinery.

Ho_4: There is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on teacher-students' interaction

Ho_5: There is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on student-student interaction.

Ho_6: There is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on engagement.

The review of literature indicates that; the use of instructional materials has attracted attention in the field education. While it offers tremendous opportunities to improve instructional delivery, it also points to concerns about flexibility and adaptability in teaching and learning. In their study which examine strategies for improving students' skills in building electronic system in universities in Rivers, Nwakanma et al. (2024) discovered that, the teachers and the instructors were generally optimistic about the inherent benefits of using audio-visual materials improving students' skills in building electronic system. On the other hand, the students acknowledged the potential benefits audio-visual materials, but expressed great concern on its flexibility and adaptability in addressing each students' need. Another factor that raises concern on use instructional materials is engagement. Mohammed (2016) who research on development and validation of instrument for assessing practical skills in domestic installation processes in Technical Colleges stated engagement is one the attributes of a good instructional material. In other words, any instructional material that does not promoted engagement is less likely to improve students' performance.

Also, the study of Daniel (2021) examined the effect of AI generated multimodal resource materials on students' academic achievement in Radio, Television and Electronic Works in Technical Colleges. The findings of the study showed students taught with AI generated multimodal resource materials did better academically than those taught with posters. However, the findings of the study indicated that, the use of AI generated multimodal resource materials it did not sustain their retention. Similarly, Henry (2022) studied the effect of AI curated multimodal resource materials on students' performance in Welding and Fabrication in Technical Colleges. The findings of study revealed that, students taught with AI multimodal curated learning materials performed better than those taught with flip charts. The findings of the study also revealed that, the use of AI multimodal curated resource materials did sustain their retention.

Consequently, like the previous studies that examined the effect of audio-visual materials, AI generated multimodal resource materials and AI multimodal curated resource materials on students' performance and retention, the present study also examined the effect of AI powered multimodal learning materials on students' performance and retention. This study further examined the effect AI powered multimodal learning materials on students' interest, teacher-students' interaction, student-student interaction and engagement; unlike the previous studies. The study therefore, filled the gaps that existed in the previous studies

The theories that relate to this study are Cognitive Flexibility Theory and Instructional Skills and Competency Skills Theory/ Cognitive Flexibility Theory was propounded by Rand J. Spiro, Paul J. Feltovich, Richard L. Coulson and Brian K. Britton in 1980s/1990s. This theory highlights the ability to spontaneously reconfigure one's understandings to adapt to novel and dynamic situations (Kingsley, 1984). It emphasizes the importance of diversified learning experiences to develop flexible and

transferable understandings. The theory guided this study in developing and utilizing teaching aids that addresses student's learning styles and needs. On the other hand, Instructional Skills and Competency Skills Theory was propounded by Benjamin Bloom, Robert Gagne and David Merrill in 1950. This theory posits that teachers should possess the skills and competencies to implement individualized instructional resources and adapt to changing classroom dynamics (Dan, 1977). The theory guided this study in developing and utilizing multimodal learning materials that will help the teacher to increase students' motivation and participation in the class and workshop.

Methods

The study adopted Quasi-experimental and Descriptive Survey designs. It was conducted in all the 20 Government Craft Development Centres in five South-South states in Nigeria. The population of the study was 346; which comprised 316 Level II students and 30 teachers in carpentry and joinery craft in carpentry and joinery craft in five states. No sampling technique was employed for this study since the population was manageable. The study made use of intact class. Questionnaire and performance test was used for data collection. The instruments were validated by three experts. The reliability of instruments was tested through a pilot study in 2 Government Craft Development Centres in South-East states of Nigeria. The reliability coefficient of 0.78 and 0.76, was obtained with use of Kuder-Richardson formula 20 and Cronbach's Alpha for performance test items and questionnaire respectiviley. Mean and Standard Deviation were used in answering the research questions while ANCOVA and z-test were used in testing the hypothesis at 0.05 level of significance. A criterion reference Mean of 3.00 was used in answering the research questions. Hence any item that had a Mean of 3.00 and above was regarded as Great Extent whereas any item that had a Mean below 3.00 was regarded as Small Extent. The hypotheses were accepted when the p-value was higher than 0.05 level of significance or otherwise rejected.

Techniques

In carrying out quasi-experiment, Level II students in each Development Centre were randomly organized into two groups namely; the experimental group and control group; with 158 students in each group. The students in the experimental and control groups were Pre-tested to examine their entry level of achievement and scores were obtained. Thereafter, the researcher briefed carpentry and joinery teachers on how to carry out the AI multimodal learning materials in the experimental group. The experimental group was exposed to the treatment (AI multimodal learning materials) while the control group was exposed to flip charts. The study duration was four (4) weeks. with intense supervision by the researcher during the teaching and learning processes. At the end of the four weeks of teaching, a Post-test was administered on both groups, which lasted for 1 hour 30 minutes. The numbering pattern and options in the Pre-test questions were rearranged and given again to the students as post-test. A retention test which lasted for 1 hour 30 minutes again was administered on both groups after 3 weeks to investigate the level of retention. During class activities, pretest, post-test and retention tests, both groups were separated to prevent class interaction. Also, a questionnaire items on engagement, teacher-students' interactions, student-student interaction and interest were administered to both teachers and students. The scores and responses obtained were used for analysis.

Studied Material

The studied materials used were well developed lesson plans, carpentry and joinery achievement test and questionnaire. The lesson plan had topics on Workshop Rules and Regulations, Personal Protective Equipment, Workshop Sanitation/Housekeeping, Workshop Accidents, Sources of Workshop Accidents, First Aid – Definitions and Uses, First Aid Materials and Applications, Hand Tools – Classification/Identification, Geometrical/Marking Tools, Percussion/ Impelling Tools, Holding and Supporting Tools, Cutting Tools and Uses of Hand Tools. The carpentry and joinery achievement test had 50 multiple choice questions covering all the topics taught. The items of the achievement test were constructed in accordance with the six classes of cognitive domain of Bloom's taxonomy of educational objectives; namely, knowledge, comprehension, application, analysis, synthesis and evaluation. The questionnaire contains 6 on interest, 4 items on teacher-students' interaction, 7 items on student-student interaction and 6 items on engagement structured in 5 points rating scale of Very

Great Extent, Great Extent, Moderate Extent, Small Extent and Very Small Extent with the numerical values of 5, 4, 3, 2 and 1 respectively.

Area Descriptions

The study was conducted in the South-South Nigeria covering Rivers, Bayelsa, Akwa-Ibom, Cross River, Delta and Edo States. Generally, these states share land borders with Imo, Abia, Enugu, Ebonyi and Anambra States and the republic of Cameroon. Geographically, the South-South states are located along the distributaries of Niger River and the Atlantic Ocean. A predominant feature of these states is the existence of tropical rain forests filled with mangroves and the huge deposit of mineral resources such as crude oil, coal and gas. The states thrive economically due the activities of multinational cooperation, industries and companies involved in oil exploration, drilling and exportation and agriculture. In order to provide high level skilled manpower for these organizations, the states have crafts development centres to fill this need. Hence the choice of South-South Nigeria as the area of study was appropriate.

Results

Research Question 1. What is the effect of AI multimodal learning materials on students' academic performance?

Data obtained in respect to research question 1 were analyzed and presented in Table 1

Table 1: Mean and standard deviation scores of students taught with AI multimodal learning materials and flip chart

Groups	No	Pre-test		Post-test		Mean difference	Mean gain
		$\bar{X}$	SD	$\bar{X}$	SD		
Experimental	158	8.81	2.14	16.21	0.43	7.40	2.01
Control	158	9.43	2.15	14.82	2.16	5.39	

The results in Tables 1 shows that the students (experimental group) taught with AI multimodal learning materials had a pre-test mean score (8.81) with a standard deviation (2.14); and a post-test mean score (16.21) with a standard deviation (0.43). while the students (control group) taught with flip chart had a pre-test mean score (9.43) with a standard deviation (2.15)); and a post-test mean score (14.82) with a standard deviation (2.16). The mean difference (7.40) of students taught with AI multimodal learning materials was higher than (5.39) of students taught with flip charts; resulting a mean gain (2.01). Also, the scores of standard deviations of both groups revealed that the scores of students taught with AI multimodal learning materials were homogenous (0.43) while those taught with flip charts were heterogeneous (2.16). This shows that the mean performance scores of students taught with AI multimodal learning materials was higher than those taught with flip charts. Therefore, the use of AI multimodal learning materials improved students' performance.

Research Question 2. What is the effect of AI multimodal learning materials on students' retention?

Data obtained in respect to research question 2 were analyzed and presented in Table 2

Table 2: Mean and Standard Deviation Retention Scores of Students with taught with AI multimodal learning materials and flip chart

Groups	No	Post-test		Retention		Mean difference	Mean gain
		$\bar{X}$	SD	$\bar{X}$	SD		
Experimental	158	16.21	0.43	17.67	0.57	1.46	Retained more
Control	158	14.82	2.16	13.89	1.78	0.93	

Data analysis in Table 2 indicates that the students (experimental group) taught with AI multimodal learning materials had post-test mean score (16.21) with a standard deviation (0.43); and a retention score (17.67) with standard deviation (0.57). While the students (control group) taught with flip chart had a post-test mean score (14.82) with a standard deviation (2.19); and retention score (13.89) with the

standard deviation (1.78). The mean difference (1.46) show that students taught with AI multimodal learning materials retained more than the students taught with flip chart having a difference in mean (0.93). The analysis therefore revealed that, the mean retention scores of students taught with AI multimodal learning materials was higher than the students taught with flip chart.

Research Question 3. What extent of effect does the use of AI multimodal learning materials have on students' interest?

Data obtained in respect to research question 3 were analyzed and presented in Table 3.

Table 3. Respondents mean scores on the extent of effect the use of AI multimodal learning materials have on students' interest

S/N	Items	Respondents					
		Teachers			Students		
	Aspects of Students' Interest	$\bar{X}_1$	SD_1	**Remark**	$\bar{X}_2$	SD_2	**Remark**
1.	To what extent does AI multimodal learning materials make learning relevant and applicable to real-life situations	3.50	.47	GE	3.72	.63	GE
2.	To what extent does AI multimodal learning materials make use of narratives to convey complex concepts and make learning more relatable	3.54	.52	GE	3.59	.79	GE
3.	To what extent does AI multimodal learning materials provide constructive feedback and encouragement to motivate students and promote growth.	3.62	.56	GE	3.51	.82	GE
4	To what extent does AI multimodal learning materials promote some autonomy in learning, such as choosing topics or working at their own pace.	3.51	.58	GE	3.74	.44	GE
5.	To what extent does AI multimodal learning materials incorporate different teaching methods, activities, and resources to keep learning interesting and dynamic.	3.51	.72	GE	3.58	.54	GE
6.	To what extent does AI multimodal learning materials incorporate elements of fun and enjoyment into the learning process to promote motivation and enthusiasm	3.53	.53	GE	3.63	.77	GE
	Cluster Mean	**3.54**	**.56**	GE	**3.58**	**.66**	GE

Results in Table 3 shows that all the items have a cluster mean (3.54) for teachers and (3.58) for students respectively. This means that the use of AI multimodal learning materials had effect on students' interest in carpentry and joinery to a great extent. The cluster standard deviations (.56) for teachers and (.66) for students respectively, show that the respondents were homogenous in their opinions.

Research Question 4. What extent of effect does the use of AI multimodal learning materials have on teacher-students' interaction?

Data obtained in respect to research question 4 were analyzed and presented in Table 4.

Table 4. Respondents Mean scores on the extent of effect the use of AI multimodal learning materials have on teacher-students' interaction

S/N	Items	Respondents					
		Teachers			Students		
	Aspect of teacher-students' interaction	$\bar{X}_1$	SD_1	Remark	$\bar{X}_2$	SD_2	Remark
1.	To what extent does AI multimodal learning materials promote verbal interaction	3.57	.51	GE	3.46	.86	GE
2.	To what extent does AI multimodal learning materials promote discussion	3.57	.53	GE	3.45	.88	GE
3.	To what extent does AI multimodal learning materials promote explanation	3.55	.46	GE	3.78	.98	GE
4	To what extent does AI multimodal learning materials promote feedback	3.57	.64	GE	3.83	.97	GE
	Cluster Mean	**3.57**	**.54**	GE	**3.63**	**.92**	GE

Results in Table 4 shows that all the items have a cluster mean (3.57) for teachers and (3.63) for students respectively. This means that the use of AI multimodal learning materials had effect on teacher-students' interaction to a great extent. The cluster standard deviations (.54) for teachers and (.92) for students respectively, show that the respondents were homogenous in their opinions.

Research Question 5. What extent of effect does the use of AI multimodal learning materials have on student-student' interaction?
Data obtained in respect to research question 5 were analyzed and presented in Table 5

Table 5. Respondents Mean scores on the extent of effect the use of AI multimodal learning materials have on student-student' interaction.

S/N	Items	Respondents					
		Teachers			Students		
	Aspect of student-student' interaction	$\bar{X}_1$	SD_1	Remark	$\bar{X}_2$	SD_2	Remark
1.	To what extent does AI multimodal learning materials promote think-pair-share	3.51	.56	GE	3.55	.72	GE
2.	To what extent does AI multimodal learning materials promote group Work	3.50	.50	GE	3.45	.98	GE
3.	To what extent does AI multimodal learning materials promote role-playing	3.59	.49	GE	3.58	.95	GE
4	To what extent does AI multimodal learning materials promote group discussions	3.51	.54	GE	3.64	.75	GE
5.	To what extent does AI multimodal learning materials promote peer-to-peer feedback.	3.61	.41	GE	3.86	.94	GE
6.	To what extent does AI multimodal learning materials build relationships among students	3.51	.47	GE	3.59	.79	GE
7.	To what extent does AI multimodal learning materials promote clear communication among students	3.54	.49	GE	3.62	.78	GE
	Cluster Mean	**3.54**	**.49**	GE	**3.61**	**.84**	GE

Results in Table 5 indicates that all the items have a cluster mean (3.54) for teachers and (3.61) for students respectively. This means that the use of AI multimodal learning materials had effect on student-student' interaction to a great extent. The cluster standard deviations (.49) for teachers and (.84) for students respectively, show that the respondents were homogenous in their opinions.

Research Question 6. What extent of effect does the use of AI multimodal learning materials have on engagement?

Data obtained in respect to research question 6 were analyzed and presented in Table 6.

Table 6. Respondents Mean scores on the extent of effect the use of AI multimodal learning materials have on engagement

S/N	Items	Respondents					
		Teachers			Students		
	Aspect of engagement	$\bar{X}_1$	SD_1	**Remark**	$\bar{X}_2$	SD_2	**Remark**
1.	To what extent does AI multimodal learning materials promote clear, concise, and respectfully communication between teachers and students.	3.54	.57	GE	3.53	.72	GE
2.	To what extent does AI multimodal learning materials provide constructive feedback and encouragement between teachers and students.	3.50	.50	GE	3.53	.98	GE
3.	To what extent does AI multimodal learning materials help teachers to be flexible and adaptable in their teaching approaches to meet diverse student needs.	3.54	.44	GE	3.54	.55	GE
4	To what extent does AI multimodal learning materials help students to actively participate in class discussions, activities, and projects.	3.58	.53	GE	3.74	.45	GE
5.	To what extent does AI multimodal learning materials encourage students to explore their curiosity and interests in the subject matter.	3.62	.41	GE	3.56	.74	GE
6.	To what extent does AI multimodal learning materials encourage students to reflect on their learning and self-assess their progress.	3.54	.47	GE	3.56	.79	GE
	Cluster Mean	**3.55**	**.49**	GE	**3.59**	**.67**	GE

Results in Table 6 reveals that all the items have a cluster mean (3.55) for teachers and (3.59) for students respectively. This means that the use of AI multimodal learning materials had effect on engagement to a great extent. The cluster standard deviations (.49) for teachers and (.67) for students respectively, show that the respondents were homogenous in their opinions.

Hypothesis 1. There is no significant difference between the mean scores of students taught carpentry and joinery with AI multimodal learning materials and students taught with flip chart.
Data obtained in respect to hypothesis 1 were analyzed and presented in Table 7.

Table 7: The Analysis of Covariance (ANCOVA) scores of students taught with AI multimodal learning materials and flip chart

Source	Type III sum of squares	df	Mean Square	F	Sig
Corrected Model	4748.755[a]	2	2374.378	5.362	.008
Intercept	111603.474	1	111603.474	252.045	.000
Postest1	267.866	1	267.866	.605	.441
Group	4085.989	1	4085.989	9.228	.010
Error	20811.245	314	442.792		
Total	5791968.000	316			
Corrected Total	25560.000	315			

The analysis of covariance of students' performance mean scores presented in Table 7 showed that, the p value (0.010) was lower than 0.05 level of significance at degree of freedom (314). This implies that the means scores of the two groups of students was significant. Therefore, the hypothesis was rejected.

Thus, there is significant difference between the mean scores of students taught carpentry and joinery with AI multimodal learning materials and students taught with flip charts.

Hypothesis 2. There is no significant difference between the mean retention scores of students taught carpentry and joinery with AI multimodal learning materials and students taught with flip charts.

Data obtained in respect to hypothesis 2 were analyzed and presented in Table 8.

Table 8: The Analysis of Covariance (ANCOVA) Table Showing Difference Between Students Taught with E-Learning facilities and those Taught with cardboard paper in surface wiring.

Source	Type III sum of squares	Df	Mean Square	F	Sig
Corrected Model	8757.883[a]	2	4378.941	13.103	.000
Intercept	127373.416	1	127373.416	381.148	.000
Postest1	1.827	1	1.827	.005	.941
Group	8754.667	1	8754.667	26.197	.030
Error	15706.617	314	334.183		
Total	5512449.000	316			
Corrected Total	24464.500	315			

The analysis of covariance of students' performance mean scores presented in Table 8 showed that showed that the p value of (0.030) was lower than at 0.05 level of significance at degree of freedom (314). This implies that the means scores of the two groups of students was significant. Therefore, the hypothesis was rejected. Thus, there is significant difference between the mean retention scores of students taught carpentry and joinery with AI multimodal learning materials and students taught with flip charts.

Hypothesis 3. There is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on students' interest in carpentry and joinery.

Data obtained in respect to hypothesis 3 were analyzed and presented in Table 9.

Table 9. Summary of z-Test Comparison of the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on students' interest in carpentry and joinery.

Category of Respondents	N	$\overline{X}$	SD	α	df	z-cal	p-value	Decision
Teachers	30	3.54	.56	.05	186	.42	.063	Not Significant
Students	158	3. 58	.66					

Data in Table 9 show a z-value (0.42) at degree of freedom (186) and a p-value (.063). Testing at alpha level (0.05), the p-value is not significant; since the p-value is greater than the alpha value (0.05). Therefore, the null hypothesis was not rejected. Hence, there is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on students' interest in carpentry and joinery.

Hypothesis 4. There is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on teacher-students' interaction

Data obtained in respect to hypothesis 4 were analyzed and presented in Table 10.

Table 10. Summary of z-Test Comparison of the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on teacher-students' interaction

Category of Respondents	N	$\overline{X}$	SD	α	df	z-cal	p-value	Decision
Teachers	30	3.57	.54	.05	186	.35	.070	Not Significant
Students	158	3. 63	.92					

Results in Table 10 indicated a z-value (.35) at degree of freedom (186) and a p-value (.070). Testing at alpha level (.05), the p-value is not significant; since the p-value is greater than the alpha value (.05). Therefore, the null hypothesis was not rejected. Hence, there is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on teacher-students' interaction.

Hypothesis 5. There is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on student-student interaction.

Data obtained in respect of hypothesis 5 were analyzed and presented in Table 11

Table 11. Summary of z-Test Comparison of the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on student-student interaction.

Category of Respondents	N.	$\overline{X}$	SD	α	df	z-cal	p-value	Decision
Teachers	30	3.54	.49	.05	186	1.47	.068	Not Significant
Students	158	3.61	.84					

Results in Table 11 indicated a z-value (1.47) at degree of freedom (186) and a p-value (.068). Testing at alpha level (.05), the p-value is not significant; since the p-value is greater than the alpha value (.05). Therefore, the null hypothesis was not rejected. Hence, there is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on student-student interaction.

Hypothesis 6. There is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on engagement.

Data obtained in respect of hypothesis 6 were analyzed and presented in Table 12.

Table 12. Summary of z-Test Comparison of the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on engagement.

Category of Respondents	N	$\overline{X}$	SD	α	df	z-cal	p-value	Decision
Teachers	30	3.55	.49	.05	186	1.34	.073	Not Significant
Students	158	3.59	.67					

Results in Table 12 indicated a z-value (1.34) at degree of freedom (186) and a p-value (.073). Testing at alpha level (.05), the p-value is not significant; since the p-value is greater than the alpha value (.05).

Therefore, the null hypothesis was not rejected. Hence, there is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on engagement.

Discussion

The finding of the study revealed that the mean performance scores of students taught carpentry and joinery with AI multimodal learning materials was higher than students taught with flip charts. The study also indicates that, there is significant difference between the mean scores of students taught carpentry and joinery with AI multimodal learning materials and students taught with flip charts. The finding agrees with Onyebuenyi (2022) who noted that, the use of AI multimodal learning materials accounts for better academic achievement among students irrespective of the learning styles of the students. The finding also supports Barcu (2023) who opined that, the use of AI multimodal learning materials is teaching technology oriented subjects improves student performance since it is activity and practical oriented. The findings of the study are also in consonance with the studies of Daniel (2021) and Daniel (2021), whose studies revealed that, the use of AI multimodal learning materials improved students' performance.

The finding of the study also shows that, the mean retention scores of students taught with AI multimodal learning materials was higher than the students taught with flip chart. The study revealed that, there is significant difference between the mean retention scores of students taught carpentry and joinery with AI multimodal learning materials and students taught with flip charts. The finding is in consonant with James (2021) who observed that, the use of instructional materials not only aid retention but also concretizes learning over a period of time. The findings of the study are also in consonance with the study of Daniel (2021), whose study revealed that, the use of AI multimodal learning materials sustained students' retention. However, the finding of the study is in contrast with the study of Henry (2022), whose study revealed that, the use of AI multimodal learning materials did not sustain students' retention.

The study also indicates that, the use of AI multimodal learning materials had great effect on students' interest in carpentry and joinery. It was discovered that the use of AI multimodal learning materials, make learning relevant and applicable to real-life situations, make learning more relatable, provide constructive feedback and encouragement to motivate students and promote growth. promote some autonomy in learning, such as choosing topics or working at their own pace, incorporate different teaching methods, activities, and resources to keep learning interesting and dynamic and incorporate elements of fun and enjoyment into the learning process to promote motivation and enthusiasm. This is in line with opinion of Adams (2018) who stated that, the use AI multimodal learning materials creates enthusiasm and promotes motivation both in teaching and learning.

The finding of the also revealed that the use of AI multimodal learning materials promoted teacher-students' interaction, student-student interaction and engagement to a great extent. This finding supported the study of Hugh (2021) who stated that, a good AI multimodal learning materials should enhance teacher-students' interaction, student-student interaction and engagement thereby increasing academic achievement among students. The study also shows that there is no significant difference between the response mean scores of teachers and students on the extent of effect the use of AI multimodal learning materials has on teacher-students' interaction, student-student interaction and engagement.

Conclusion

On the basis of the findings of the study, it was concluded that the utilization of AI multimodal learning materials improved the academic performance of carpentry and joinery students in Craft Development Centres in South-South Nigeria. The study therefore, recommended that:

1. state governments should organize training for teachers on how to develop and use AI multimodal learning materials.
2. internet facilities and networks should be provided regularly in Crats Development Centres by government to facilitate and encourage the use of AI multimodal learning materials by teachers and students

3. regular electrical power supply should be made available in Crats Development Centres by the government to encourage the use of encourage the use of AI multimodal learning materials by teachers and students

Acknowledgements

The researcher's special gratitude goes to Prof. I.Ogundu; Dean Facility of Vocational and Technical Education, Prof. J.U.A Uka; Head of Department Technical Education, for their constructive criticism and contributions to the success of this work. The researcher sincerely acknowledges his academic colleagues Dr. P. Emenu, Engr. Dr. J.O. Amaechi, Dr. D.O. Chiorlu, Dr. R. N. Robinson, Dr. A. Ibekwe, Dr. Mrs. S.N. Igweagbara, Dr. A. Nwala, Dr. C.C.R. Wordu, Mr. P.N. Akue, and Mr. J. A. Ijok for their moral support. The researcher acknowledges most especially his wife Mrs. Ijeoma Nwakanma, and his Children; Rosy, Legacy and Reliance. Above all, the researcher gives the utmost thanks to Almighty God, for giving him the strength, knowledge and wisdom to successfully completing this work.

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