Effects of Mastery Learning and Demonstration Instructional Strategies on the Academic Achievement of Basic Technology Students in Delta State

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Abstract
This study investigated the effects of mastery learning and demonstration instructional strategies on the academic achievement of Basic Technology students in Delta State, Nigeria. The study adopted a quasi-experimental research design involving 6480 (3040 male and 3440 female) students offering Basic Technology in the 1248 Public Secondary in Delta State. A sample of 316 JSS I-III Basic Technology students selected from six public mixed junior secondary schools in Delta State were used for the study. The Basic Technology Achievement Test (BTAT) developed and validated by the researcher was the main instrument for data collection. The reliability of the instrument was established using Kuder-Richardson formula 21 which yielded coefficient index as pretest of 0.79. Data were collected by administering the BTAT as pretest, posttest and post-posttest. The data obtained were analyzed using mean, standard deviation, Anova and ANCOVA. Results revealed that students taught using mastery learning and demonstration strategies performed significantly better than those taught using conventional methods. Furthermore, there was no significant gender difference in students' achievement under both strategies. The study recommends that Basic Technology teachers adopt mastery and demonstration teaching approaches to enhance students' achievement and practical competence.

Keywords: *Mastery Learning, Demonstration Method, Academic Achievement, Basic Technology, Academic Achievement*

Introduction

Education serves as the bedrock of national development, and at the core of this process lies effective teaching and learning. Any society's progress is fundamentally based on education, and effectiveness of learning is greatly influenced by the instructional strategies used in classroom (Kelubia, Umunadi & Akinseinde, 2024). Various subject including basic technology, are taught at the basic and secondary school levels to ensure that Nigerian citizens have a sufficient education. The purpose of the subject is to acquaint students with fundamentals of technology and how it is used in daily life (Milner, 2020). Specific areas of instruction include metalworking, woodworking, electrical, plastics, ceramics, textiles, and technical drawing

(kelubia, Umunadi & Akinseinde, 2024). Using suitable teaching strategies during instruction is necessary to support junior secondary schools in achieving the goals of the basic technology curriculum. The way that educators choose to teach can either help or hinder how well their students learn basic technology (Obomanu, 2021). In the context of Basic Technology—an integrated subject designed to expose students to the rudiments of technological skills—teaching effectiveness is often influenced by the instructional strategies employed by teachers. Basic technology refers to the fundamental understanding and knowledge of natural phenomena, principles, and processes, as well as the practical application of scientific knowledge to develop technological solutions (Rosenberg, 2022). The persistent decline in students' performance in Basic Technology in Nigerian secondary schools has been attributed partly to the use of traditional lecture method, teacher-centered methods that emphasize rote learning rather than active participation and skill acquisition (Owolabi, 2020; Nwachukwu, 2021).

The lecture technique is a traditional pedagogical method where a teacher systematically communicates instructional content to a group of pupils (Emerhiona, Ajaja, Nwanze & Izueguna, 2018). This approach is frequently employed in a variety of educational contexts, such as colleges, universities, and even certain high classrooms. The lecture method of teaching involves the teacher in complete verbal instruction telling the students what he/she feels they should know without giving the students the opportunity to be actively involved during the teaching and learning process. Ajaja(2016) stated during the lecture class, the teacher engages in speaking and reading and often illustrating with visual instructional materials. He further stated that the students are passive listeners during the teaching-learning process. The passive aspect of traditional lecture method may be responsible for students fluctuating performance in the Basic Education Certificate Examination (BECE).

Instructional strategies such as mastery learning and demonstration have been identified as potential approaches to improving students' understanding and achievement. Mastery learning, proposed by Bloom (1968), is based on the principle that almost all learners can achieve high levels of understanding if given sufficient time and appropriate instruction. It emphasizes systematic instruction, corrective feedback, and enrichment activities, allowing students to progress at their own pace until mastery is attained (Guskey, 2010). According to James (2021), mastery-based learning methods emphasize that instruction should be tailored to the individual time needed for each student to master the same content. This is very much in contrast with classic models of teaching that focus on varying student abilities and allocation of equal time and instructions irrespective of the students' unique needs. Winget and Persky (2024) posits that, mastery learning shifts the perspective, attributing student challenges to instructional methods rather than inherent abilities. Therefore, the task in mastery learning is to ensure sufficient time and employ effective instructional strategies so that all students can achieve the same level of learning (Anderson, 2024).

On the other hand, the demonstration method emphasizes visual and practical exposure to concepts, enabling learners to observe and replicate the teacher's actions during instruction. Demonstration strategy has been found to enhance psychomotor and cognitive learning outcomes, especially in skill-oriented subjects like Basic Technology (Eze & Okonkwo, 2019; Adeyemi, 2022). Kelubia et al. (2024) posits that an educational strategy that places a strong emphasis on active engagement and hands-on learning is the experimental demonstration teaching technique. The teacher uses the experimental demonstration approach to demonstrate to the students how to use basic technology concepts and ideas to carry out specific tasks or achieve specific things. According to Ameh, Daniel, and Akus (2007) Demonstration method is a display

or exposition that the instructors often holds as students watch with bated breath. The authors said it includes showing how something works or how a process works. Saving time and encouraging material economy; attracting attention and motivating students; giving students quick feedback through their own creations; and motivating students when taught by a skilled teacher are some of the benefits of it. The scientific and vocational education communities are becoming increasingly interested in the demonstration method as an instructional strategy (Kelubia, Okpokor, Ugboh & Orhu). When students can participate, interact, and manipulate things and equipment, the demonstration technique will help to improve students' academic achievement.

Academic achievement is how well a student, instructor, or institution meets its short- and long-term educational goals (Kelubia et al., 2023). It is often measured by grades, test scores, and other indicators of academic performance. Academic achievement is an important aspect of a student's overall development and can have a significant impact on their future success. Sheoran and Sethi (2016) defined academic achievement as the sum total of information gained after completing a course of instruction (partially or fully) in a particular grade obtained on an achievement test. It is the expression of students' performance in a given content area in numerical form. The success or failure of a student is measured in terms of academic achievement. There are many factors that can influence a student's academic achievement. These can include individual characteristics such as sex, intelligence, motivation, study habits and retention ability among others.

Student sex refers to the biological classification of participants as male or female. In this study, sex is treated as moderating variable that may influence the effect of mastery learning and demonstration strategies on students' academic achievement in basic technology. In Delta State, Nigeria, Basic Technology is a core subject at the junior secondary school level, aimed at developing students' manipulative and problem-solving abilities necessary for technological advancement. However, reports from the Delta State Ministry of Education (2023) indicate a consistent decline in students' performance in the subject over the past five years. This situation calls for the adoption of more effective instructional strategies that engage learners actively and promote deeper understanding of technical concepts.

Statement of Problem

Despite the relevance of Basic Technology to Nigeria's technological development, students' performance in the subject in Delta State has remained unsatisfactory. However, Becky (2015) discovered that, the teaching of Basic Technology has been seriously hindered by lack of instructional strategies, poor administrative management, school location, school environment, type of school ownership and most importantly lecture methods of teaching especially the lack of the use of mastery learning and demonstration instructional strategies in teaching which have led to poor performance in external examinations. This persistent poor performance may be due to poor methods of teaching. Observations from classroom practices reveal that many teachers still rely heavily on lecture methods, which limit students' participation and hinder conceptual understanding. Consequently, many students exhibit low achievement, poor motivation, and limited interest in technology-related fields (Ogunleye, 2021).

This situation raises concern about the need for alternative instructional approaches that promote meaningful learning and skill acquisition. Hence, this study seeks to determine the effects of mastery learning and demonstration instructional strategies on the academic achievement of Basic Technology students in Delta State.

Purpose of the study

The primary purpose of the study was to find out how Delta State basic technology students' academic achievement was affected by mastery learning, demonstration instructional strategies and lecture method. In particular, the research aimed to ascertain:

1. If there is any significant effect of the mean academic achievement scores of secondary school students taught Basic Technology using mastery learning method, demonstration instructional strategies, and lecture method.
2. If there is any significant effect of the interaction between methods (mastery learning method, demonstration instructional strategies, and lecture method) and sex on students' academic achievement in Basic Technology.

Research Questions

Two research questions served as a guide for the research:

1. What is the difference in the mean academic achievement scores among students taught Basic Technology using mastery learning, demonstration instructional strategy and lecture method?
2. What is the effect of interaction between methods (mastery learning method, demonstration instructional strategies, and lecture method) and sex on students' academic achievement scores in Basic Technology?

Research Hypotheses

The following hypotheses served as a guide for the research:

1. There is no significant difference in the mean academic achievement scores among students taught Basic Technology using mastery learning, demonstration instructional strategy and lecture method.
2. There is no significant effect of interaction between methods (mastery learning method, demonstration instructional strategies, and lecture method) and sex on students' academic achievement scores in Basic Technology.

Research Method

The study focused on the comparative study of the effects of mastery learning and demonstration instructional strategies on the academic achievement of Basic Technology students in Delta State. Two research questions and two hypotheses guided this study. The research design was quasi-experimental design, specifically non-equivalent pre-test; post-test planned variation design, population of the study was junior secondary (JSSI-III) students. There are 492 public secondary schools in Delta State with 14,269 teachers and 492 principals and 281,284 students (140,461 males and 140,823 females). The study population comprise of 6,480 (3,040 male and 3,440 female) students offering Basic Technology in the 492 public secondary schools in Delta State (Delta State Ministry of Education; Universal Basic Education Board, 2024) which make up the total population of this study. The sample of this study consists of 316 participants, drawn from selected junior secondary schools in Delta State. The researcher therefore randomly selected 377 junior secondary school students in the selected schools in Delta State using the stratified random sampling technique from the sampled schools.

The instrument used for data collection in the study was a Basic Technology Achievement Test (BTAT) drawn from a six weeks, instructional unit in Basic Technology on; technical drawing, building construction, wood/metal work, and electronics designed by the researcher which was

validated using expert judgment of a panel of three experts made up of one experienced Basic Technology teacher drawn from one public secondary school outside the State, one Education Teaching from Delta State University and an expert (Lecturer) in the Department of Technical Education, Delta State University Abraka. The reliability of the (BTAT) was established using Kuder-Richardson formula 21. This was done by administering the (BTAT) established using 45 Basic Technology students outside the area of the study and computing the reliability. The reliability co-efficient of the instrument was found to be 0.79.

The treatment involved exposing the students in the experimental groups to the Basic Technology concepts "technical drawing, building construction, wood/metal work, and electronics" with the used of instructional strategies (mastery learning and demonstration method and the control the group with the lecture method the pre-test were administered before the treatment and post-test there after delayed test [post-test] was administered three weeks after treatment. The scores obtained were collated and analyzed using descriptive statistics, analysis of variance (ANOVA).

Results

Research Question 1: What is the difference in the mean academic achievement scores among students taught Basic Technology using mastery learning, demonstration instructional strategy and lecture method?

Table 1: Descriptive Statistics Comparing the Pretest and Posttest Mean Achievement Scores Among Students Taught Basic Technology Using Mastery Learning, Demonstration and Lecture Method

Group	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Mastery learning strategy	112	20.04	7.24	50.89	12.42	30.85
Demonstration strategy	103	20.68	7.14	41.84	12.83	21.16
Lecture method	101	20.35	7.43	38.61	8.31	18.26

The data in table 1 shows that the three groups had a pretest mean achievement scores of 20.04, 20.68 and standard deviation of 7.24 and 7.14 for mastery learning and demonstration instructional strategies respectively (experimental groups) and a pretest mean achievement score of 20.35 and standard deviation of 7.43 for the control group. For the posttest, the experimental groups obtained a higher mean score of 50.89 with a standard deviation of 12.42 for mastery learning strategy and a mean score of 41.84 with a standard deviation of 12.83 for demonstration instructional strategy. The control group (lecture method) obtained a mean achievement score of 38.61 with a standard deviation of 8.31. Table 1 indicated that students taught with mastery learning strategy scored the highest marks. This was followed by students taught with demonstration instructional strategy and lecture method (control) groups respectively. All the experimental groups (mastery learning and demonstration instructional strategies) scored higher marks than the control group (lecture method).

Hypothesis 1: There is no significant difference in the mean academic achievement scores among students taught Basic Technology using mastery learning, demonstration instructional strategy and lecture method.

Table 2: ANOVA comparison of the Pretest Scores of Students in Mastery learning, demonstration instructional strategies (Experimental) and Lecture (control) Groups

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	21.634	2	10.817	.205	.815
Within Groups	16540.075	313	52.844		
Total	16561.709	315			

The ANOVA comparison of the groups as shown in Table 2 indicated non-significant difference, F (2, 313) = 0.205, P(0.815) > 0.05. This implies that there is no significant difference in the pre-test scores of the three groups compared. Hence, ANOVA was used to test hypothesis 1.

Table 3: ANOVA Comparison of the Posttest Scores of Students in Mastery Learning, Demonstration Instructional Strategies (Experimental) and Lecture (control) Groups

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	8729.717	2	4364.858	33.472	.000
Within Groups	40816.169	313	130.403		
Total	49545.886	315			

A significant difference was found between the group taught with mastery learning, demonstration instructional strategies and lecture method as shown in Table 4.3, F (2, 313) = 33.472, P(0.000) < 0.05. Therefore, the null hypothesis is rejected. Thus, there is a significant difference in the mean achievement scores among students taught Basic Technology using mastery learning, demonstration instructional strategies and lecture methods. The Scheffe's Post-Hoc test in Table 4 shows the direction of the difference

Table 4: Scheffe's Post-Hoc Test to Compare the Mean Achievement Scores of Students in the Experimental and Control Groups

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Mastery	Demonstration	9.048*	1.559	.000	5.21	12.88
	Lecture	12.279*	1.567	.000	8.42	16.13
Demonstration	Mastery	-9.048*	1.559	.000	-12.88	-5.21
	Lecture	3.231	1.599	.132	-.70	7.16
Lecture	Mastery	-12.279*	1.567	.000	-16.13	-8.42
	Demonstration	-3.231	1.599	.132	-7.16	.70

The scheffe's post-hoc analysis in Table 4 shows that there is a significant difference in the mean achievement scores of students taught Basic Technology using mastery learning strategy and those taught using demonstration instructional strategy in favour of mastery learning strategy. There is also a significant difference in the mean achievement scores of students taught Basic Technology using mastery learning strategy and those taught using lecture method in favour of mastery learning strategy. There is also a significant difference in the mean achievement scores of students taught basic technology using demonstration instructional strategy and those taught

using lecture method in favour of demonstration instructional strategy. Table 4 shows that out of the three methods, mastery learning strategy proved most effective followed by demonstration instructional strategy.

Research Question 2: What is the effect of interaction between methods (mastery learning method, demonstration instructional strategies, and lecture method) and sex on students' academic achievement scores in Basic Technology?

Table 5: Descriptive Statistics on Interaction Effect Between Teaching Methods and Sex on Students' Mean Achievement Scores in Basic Technology

Methods		**Mastery learning**			**Demonstration**			**Lecture**	
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Pretest									
Male	49	20.61	7.33	46	21.09	7.30	40	20.75	7.56
Female	63	19.60	7.20	57	20.35	7.06	61	20.08	7.39
Differences		**1.01**	**0.13**		**0.74**	**0.24**		**0.67**	**0.17**
Posttest									
Male	49	53.67	11.89	46	39.57	11.39	40	38.12	8.37
Female	63	48.73	12.48	57	43.68	13.71	61	38.93	8.32
Differences		**4.94**	**-0.59**		**4.11**	**2.71**		**0.81**	**0.05**

Table 5 shows a mean achievement score of 53.67 and 39.57 for male students who were taught with mastery learning and demonstration instructional strategies (experimental groups), while their female counterparts had a mean achievement scores of 48.73 and 43.68 respectively. Male students who were taught with lecture method had a mean achievement score of 38.12 while their female counterparts had a mean achievement score of 38.93. The results do not suggest interaction effect between teaching methods and sex on students' achievement in Basic Technology. This was because at all the levels of sex, the mean achievement scores were higher for students in the experimental groups. However, the results also suggest interaction effect between demonstration instructional strategy and sex. Table 5 indicated a pretest mean achievement score of 21.09 and a posttest mean achievement score of 39.57 for male, while their female counterpart recorded a pretest mean achievement score of 20.35 and a posttest mean achievement score of 43.68. This showed that the female students performed better than their male counterparts when taught using demonstration instructional strategy.

Hypothesis 2: There is no significant effect of interaction between methods (mastery learning method, demonstration instructional strategies, and lecture method) and sex on students' academic achievement scores in Basic Technology.

Table 6: ANCOVA Summary of Interaction Effect of Sex and Teaching Methods on Students' Mean Achievement Scores in Basic Technology

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	10232.264[a]	6	1705.377	13.404	.000
Intercept	77078.368	1	77078.368	605.826	.000
Pre	381.299	1	381.299	2.997	.084
Meth	9080.411	2	4540.205	35.685	.000

Sex	1.243	1	1.243	.010	.921
Meth * Sex	130.827	2	565.414	1.444	.073
Error	39313.622	309	127.229		
Total	661850.000	316			
Corrected Total	49545.886	315			

Table 6 shows that there is no significant interaction effect between sex and teaching methods as measured by the students' mean achievement scores in Basic Technology, F(2, 309) = 1.444, P(0.073) > 0.05. Therefore, the null hypothesis is not rejected. Thus, there is no significant interaction effect between sex and teaching methods as measured by the mean scores in Basic technology Achievement Test (CAT). This implies that the students' achievement scores relative to the teaching methods is not influenced by students' sex.

Discussion

The results from the analysis of the interaction effect between teaching methods and sex on students' academic achievement in Basic Technology suggest that there was no significant interaction effect between the two factors. This means that the relationship between the method of instruction (mastery learning, demonstration, or lecture) and students' academic achievement was not significantly influenced by sex. However, interestingly, there was a noticeable variation in the performance of male and female students across the different teaching methods.

The study shows that male students performed better than female students in the mastery learning strategy, with male students achieving a mean posttest score of 53.67 compared to 48.73 for female students, a mean difference of 4.94. In contrast, female students performed better in the demonstration instructional strategy, scoring 43.68 compared to 39.57 for male students, with a mean difference of 4.11. For the lecture method, both male and female students had nearly identical scores, with males scoring 38.31 and females scoring 38.91, showing only a marginal difference of 0.60.

Despite these observed differences in achievement based on sex and instructional method, the ANCOVA analysis shows that there is no significant interaction effect between sex and teaching method on academic achievement (F = 1.444, P = 0.073), which means that the sex differences in achievement are not dependent on the method of instruction. In other words, although there were some sex-based variations in scores, these differences did not vary significantly across the different teaching methods.

This lack of significant interaction effect could suggest that teaching methods in isolation have a more direct impact on academic achievement than sex does. In other words, regardless of whether a student is male or female, the teaching method itself (mastery learning, demonstration, or lecture) has a primary influence on their academic performance. However, the noticeable sex-based differences in achievement in some groups (such as males outperforming females in mastery learning and females outperforming males in demonstration) indicate that sex-related factors may still influence learning outcomes to some extent, even if these influences are not significantly modified by the teaching method.

One probable reason for the lack of significant interaction effect could be that the teaching methods used in the study may not have fully addressed or capitalized on potential sex-related differences in learning styles. For example, while mastery learning may favor male students, it may also be the case that both male and female students could benefit from its structured, individualized approach if they were provided with more personalized feedback or support.

Similarly, the demonstration method, which involves practical, hands-on activities, may engage female students more effectively, as shown by their higher scores in this group, but the overall impact of the teaching method does not appear to be significantly influenced by sex across all groups.

In conclusion, while sex-based differences in achievement were observed in some of the teaching methods, the statistical analysis did not reveal a significant interaction effect between teaching methods and sex. This suggests that while sex may influence students' academic outcomes to a certain extent, it does not significantly modify the effectiveness of the teaching methods in Basic Technology. Therefore, it is crucial for educators to recognize the individual needs of students based on their learning preferences rather than assuming sex-based differences will necessarily impact the efficacy of teaching methods.

Conclusion

The study came to the following conclusion: instructional strategies employed had a significant impact on the academic achievement of students in Basic Technology. The mastery learning strategy proved to be the most effective, as students taught using this method achieved the highest posttest scores compared to those taught using the demonstration strategy and the lecture method. The demonstration strategy was also more effective than the lecture method, although not as effective as mastery learning. Sex differences in academic achievement were observed, with male students outperforming female students when taught using the mastery learning strategy. However, no significant differences between male and female students were found when using the demonstration instructional strategy or the lecture method. Furthermore, the study found no significant interaction between teaching methods and sex, meaning that the effectiveness of the teaching strategies was not influenced by students' sex. In conclusion, while both mastery learning and demonstration instructional strategies have positive effects on student achievement in Basic Technology, sex did not significantly affect the outcome, except in the case of mastery learning.

Recommendations

The following are the recommendation of the study:

1. Teachers should prioritize mastery learning and demonstration instructional strategies for teaching Basic Technology, as they have proven to significantly improve students' academic achievement. These methods encourage active participation and deeper understanding among students.
2. Schools should invest in the professional development of teachers, especially in the areas of mastery learning and demonstration techniques, to ensure that they are adequately equipped to implement these strategies effectively.

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