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Effects of Differentiated Instruction on Performance in the Concept of Derivative Function among Polytechnic Students in Kebbi State

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Abstract
There are several methods of teaching; lecturing, demonstration and discussion methods, while some teachers focus on principles while others on applications. This therefore affects the level of students' understanding and prior preparation of his or her learning style. The derivative functions are fundamental concept for the basis of calculus and are used in many areas including mathematical modelling, engineering, physics, economics, etc. Thus, this study intends to investigate the effects of differentiated instruction on performance in the concept of derivative functions among polytechnic students in Kebbi state. A quasi-experimental research design was used for this study, National Diploma two (ND II) polytechnic students in Kebbi state during the 2020/2021 academic session constitutes the population of the study. Simple random sampling technique was used to select a sample size of 100 ND II polytechnic students in Kebbi state. A Derivative Functions Performance Test (DFPT) was used for the study as the DFPT was validated by experts as various suggestions were noted to improve its validity. The instrument was pilot tested and gave a reliability index of 0.79 using Cronbach's alpha reliability test. Descriptive statistic was used to answer the research questions and t-test was used to test the null hypothesis at 0.05 level of significance. The findings revealed that polytechnic students' taught concepts of derivative functions using differentiated instruction have significant effect on their performance compared to those exposed to lecture method. It was furthermore recommended that teachers should explore the use of differentiated instruction frequently.

Keywords: Differentiated instruction, derivative functions, performance, polytechnic students

Introduction
The polytechnic was designed to institute the promotion of industrial technology, technological development and transformation to serve as a change agent for both technical system and societal changes. Putting the nature of the polytechnic system in mind, it is designed to catalyze economic transformation and can be used to address the challenges of the rising unemployment and societal crises. This can be actualized by expanding the horizon of employment opportunities activities, especially where the potentials remain large and greatly unexploited (Kamoru, 2021). It is very obvious that without a proper policy on polytechnic or technical education and training there cannot be sustainable economic development in Nigeria. Government should ensure increased productivity and output, economic diversification, value addition and self-sustenance which are needed by the polytechnics (Baba, 2021). The output of the education acquired in polytechnics is visible to such an extent that uneducated could see if a failure occur. Polytechnic

graduates are supposed to solve social and economic problems sustainably. In other to do this, they need to be sufficiently equipped and informed in technical education concepts and the application of its theoretical principles in solving practical problems (Muhammad et al., 2020). In other to promote technology in Nigeria, there is the need to upgrade the standard of educational practice in all the polytechnics because the needs of the industrial sector are on the increase (Kamoru, 2021). The manpower supply is one of the greatest assets a country could have in other to develop and reviewing the curriculum to meet this need becomes paramount as the level of technical demand had greatly increased with time.

Understanding how things relate to and work in relation to other things is aided by conceptual definitions. To express abstract concepts with descriptive terms such as differentiated instruction (DI), definitions must be carefully constructed and understood rather than relying on common sense, which results in imprecise representations (Prast, et.al, 2018). Because DI is not a single arena, but a combination of both conceptual orientation and practical application, it is important for teachers to have a thorough understanding of the concept with its specific strategies in order to apply differentiation into professional practice (Prast et al., 2018). Many experts recommend DI to instructors as it is a successful method. It is known as student-aware teaching because it recognizes and teaches learners differently (Garba & Muhammad, 2015). DI is described in this study as a method of teaching that allows students to learn while taking into account their individual differences and needs. Despite its usefulness, DI implementation is sometimes found to be difficult and impractical in most circumstances (Tomlinson, 2014). It's because DI methods appear promising due to its indistinctness of the concept and in what form differentiation is successful for all ability levels (Lawrence-Brown, 2004). As a result, many educational settings have infrequent and inconsistent approaches (Alice, 2011).

The model of DI, as described by Tomlinson (2014) and Tomlinson and Imbeau (2010), provides a synthesised framework to promote the standards of inclusion and customized learning. Differentiation of instructional strategies can be grouped into four components, as shown in the framework: content, process, product, and learning environments. The content refers to what the instructor wants his/her students to learn as well as the materials or procedures through which they will learn it. Products are the means by which students demonstrate what they have learned in the lesson. Process describes learning activities designed to ensure that students use key skills required to make sense of essential ideas and information. Finally, the environment is one in which the instructor and students continue to grow in mutual respect and care while establishing a true conducive learning atmosphere (Tomlinson, 2014; Tomlinson & Imbeau, 2010). Teachers' knowledge of students' levels of readiness, interests, and learning profiles is essential to support successful and appropriate differentiation of the above factors (Garba & Muhammad, 2015). It necessitates teachers getting to know each of their students on a personal basis and must understand how each child receives classroom activities and tailor the experiences to his or her specific needs so that understanding takes place. In other words, teachers must be well aware of who and what they are teaching (Garba & Muhammad, 2015). As a result, teachers must engage students in education by using a diversity of modalities and different rates of instruction with varying degrees of complexity.

Derivative functions are fundamental concept for the basis of calculus (Garcia et al., 2011) and are used in many areas including requiring mathematical modelling of several situations in different disciplines such as engineering, physics, economics, etc. This concept was historically constructed as a way to represent rate of change which explains how one quantity changes in relation to another quantity (Weber, Tallman, Byerley, & Thompson, 2012). Differential calculus

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is a process of finding a derivative $f(x)$ of a variable x (Borji, et.al, 2018; Jones & Watson, 2018). It can be seen as the measure of the rate at which the values of the function f change with respect to the change of variable x (i.e. derivative of f with respect to x). If x & y are real number, and if the graph of f is plot against x, then the derivative is the slope obtained on the graph at each point. The instantaneous rate of change is the result of an approximation producing average rate of change over smaller and smaller intervals. Since this approximation process is related to the concept of limit, quantifying the instantaneous rate of change can be by calculating the limit of average rate of change:

$$\frac{\Delta y}{\Delta x} = \lim_{x \to 0} \frac{f(x_0 + \Delta x) - f(x_0)}{\Delta x}$$

Understanding the derivative requires a wide intuitive base of examples and related perceptions, especially concerning the concept of the rate of change in real-life problems (Weigand, 2014). Researches have shown that most students in Nigerian higher institutions view integral calculus as problematic and abstract; possibly because they have a negative attitude towards it and find it hard to comprehend, assimilate and retain. It is noted that in our tertiary institutions, calculus is one of the most poorly taught and misunderstood subjects that causes students to run away from it (Garcia et al., 2011). The differential scholastic achievement of students in Nigeria has been and is still a source of concern and research interest to educators, government and parents. This is so because of the great importance that education has on the national development of the country. All over the country, there is a consensus of opinion about the fallen standard of education in Nigeria (Adebule, 2004). Parents and government are in total agreement that their huge investment on education is not yielding the desired dividend. It is against this background that this study intends to investigate the effect of differentiated instruction on the concepts of derivative functions among polytechnic students in Kebbi state.

Objectives of the Study

The aim of this study is to investigate the effects of differentiated instruction on performance in the concept of derivative functions among polytechnic students in Kebbi state. Specifically, the objectives of this are to:

1. Determine the effect of differentiated instruction on performance in the concepts of derivative functions among polytechnic students in Kebbi state.
2. Investigate the effect of differentiated instruction on male and female polytechnic students' performance in the concepts of derivative functions in Kebbi state.

Research Questions

The following research questions were raised to guide this study:

1. Is there any difference between performances of polytechnic students' taught the concepts of derivative functions using differentiated instruction and those exposed to lecture method?
2. What is the difference between male and female polytechnic students mean scores taught the concept of derivative functions using differentiated instruction in Kebbi State?

Hypotheses

Ho_1: There is no significant difference between the performances of students taught derivative functions using differentiated instruction and those taught using lecture method.

Ho_2: There is no significant difference between the mean scores of male and female students taught the concept of derivative functions using differentiated instruction in Kebbi state.

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Methodology

A quasi-experimental research design was adopted for this study, it is used to test the effectiveness of the differentiated instruction using two groups (experimental and control) as the research samples were randomly distributed (Muhammad et al., 2021; White & McBurney, 2010). In this type of design, the groups were observed and analysed before and after being exposed to a treatment (Sani, 2017). The population of the study consists of all the National Diploma two (ND II) polytechnic students in Kebbi state during the 2020/2021 academic session. A simple random sampling technique was used to select 2 intact ND 2 classes which gave a sample size of 100 (56 experimental; 44 control) ND II polytechnic students in Kebbi state, as shown in Table 1:

Table 1: Demographic information of sample population

S/N	Group	Program	Male	Female	Total
1	Experimental	ND 2 Regular	31	25	56
2	Control	ND 2 Evening	24	20	44
		Total	**55**	**45**	**100**

The research instrument used in this research was a self-developed test. A Derivative Functions Performance Test (DFPT) was used for the study, the DFPT was validated by experts and adjustments were made in order to improve its validity. A pilot test of DFPT was conducted among students who were not part of the study sample but have similar characteristics with the target population. The instrument gave a reliability coefficient of 0.79 using Cronbach's alpha reliability test. Data were collected through pre-test and post-test, and analysis of the students' scores were measured by comparing the results of the pre-test and post-test. The results of the tests were analysed statistically using mean, standard deviation and t-test at 0.05 significance.

Results

Research Question 1

Is there any difference between performances of polytechnic students' taught the concepts of derivative functions using differentiated instruction and those exposed to lecture method?

Table 2: Mean scores of pretest and posttest of experimental group

Group	Test	N	$\bar{X}$	SD	Mean Diff.
	Pretest	56	33.21	3.29	
Experimental	Posttest	56	50.89	4.51	17.68

Table 2 revealed that the pretest mean score (33.21) was lower than that of the posttest score (50.89) with a mean difference of 17.68. The spread of scores around the mean for the above tests' comparison were 3.29 and 4.51 respectively.

Research Question 2

What is the difference between male and female polytechnic students mean scores taught the concept of derivative functions using differentiated instruction in Kebbi state?

Table 3: Mean scores of pretest and posttest of control group

Group	Test	N	$\bar{X}$	SD	Mean Diff.
	Pretest	44	32.75	3.09	
Control	Posttest	44	37.62	4.93	4.87

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Table 3 revealed that the pretest mean score (32.75) was lower than that of the posttest score (37.62) with a mean difference of 4.87. The spread of scores around the mean for the above tests' comparison were 3.09 and 4.93 respectively. The independent sample t-test was used to test the two null hypotheses at 0.05 level of significance as shown in Table 4 and 5.

Table 4: Independent sample t-test analysis for experimental and control groups at pretest

Group	N	$\bar{X}$	SD	SE_M	df	t-val.	p-value	Remark
Experimental	56	33.21	3.26	0.69	98	0.196	0.641	NS
Control	44	32.75	3.09	0.51				

NS: Not Significant

Table 4 shows the independent sample t-test statistic of both experimental and control groups on their pre-test, a significance level of alpha=0.05 was used in comparing the pre-test scores of both experimental (M=33.21, SD=3.26) and control (M=32.75, SD=3.09) groups with a difference in mean of 0.46. This difference was found to be statistically non-significant at t(98)=0.196 and p>0.05.For this test, Cohen's d was 0.039, which can be described as a very small effect size in the mean difference (Cohen, Manion & Morrison, 2017).

Null Hypothesis One

There is no significant difference between the performances of students taught derivative function using differentiated instruction and those taught using lecture methods

After the intervention process, all groups were given the same post-test to see the effect of the intervention. Independent sampled t-test statistic was used to test whether or not the mean posttest scores are statistically significant as shown in Table 5.

Table 5: Sample t-test analysis of experimental and control groups on performance

Group	N	$\bar{X}$	SD	SE_M	df	t-val.	p-value	Remark
Experimental	56	50.89	4.51	0.85	98	13.546	0.000	S
Control	44	37.62	4.93	0.91				

S: Significant

Table 5 shows the independent sample t-test statistic of both experimental and control groups on students performance, a significance level of alpha=0.05 was used in comparing the post-test scores of both experimental (M=50.89, SD=4.51) and control (M=37.62, SD=4.93) groups with a difference in mean of 13.27. This difference was found to be statistically significant at t(98)=13.546 and p<0.05. This implies that null hypothesis one is rejected, thus, there is significant difference between the performances of students taught derivative functions using differentiated instruction and those taught using lecture method.

Null Hypothesis Two

There is no significant difference between the mean scores of male and female students taught the concept of derivative functions using differentiated instruction in Kebbi state.

Table 6: Sample t-test analysis of mean scores performance and gender

Gender	N	$\bar{X}$	SD	SEM	df	t-val.	p-value	Remark
Male	55	52.16	3.99	0.95	98	12.874	0.000	S
Female	45	43.72	3.67	0.89				

Table 6 shows the independent sample t-test statistic of gender and students performance, a significance level of alpha=0.05 was used in comparing the post-test scores of both male

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(M=52.16, SD=3.99) and female (M=43.72, SD=3.67) gender with a difference in mean of 8.44. This difference was found to be statistically significant at $t(98)=12.874$ and $p<0.05$. This implies that null hypothesis two is retained, thus, there is no significant difference between the mean scores of male and female students taught the concept of derivative functions using differentiated instruction in Kebbi state.

Discussion of Findings

The differentiated instruction was found to have a significant effect on students' performance on the concepts of derivative functions among polytechnic students based on the findings of the independent sampled t-test in Table 6. The result indicates that the performance of the experimental group whom taught with differentiated instruction method is greater that the control group exposed to lecture method. The result showed that use of differentiated instruction significantly improves students' performance in the concept of derivative functions; this may be connected to the fact that teachers proactively modify curricula, teaching methods, resources, learning activities and it also address the diverse needs of students either in small groups or individually within the classroom. Though in the use of the differentiated instruction, it was discovered that polytechnic students has been able to demonstrate differential effects on productive disposition, conceptual understanding, strategic competence and adaptive reasoning. Students' cognitive skills can as well be stipulated in differentiated instruction since they are encouraged to develop their knowledge and explore beyond what the teacher provided. This finding is in agreement with the findings of Beecher and Sweeny (2008), Carol (2005), Castle et.al, (2005), Garba and Muhammad (2015), who asserted that new approach to mathematics teaching will provide opportunity for better achievement.

Based on the findings of independent sampled t-test statistic from Table 6, gender was discovered to have no significant impact on polytechnic students regarding their posttest scores performance in the concept of derivative functions. The result indicates that male students performed better than their female counterparts in integral calculus with a mean difference of 8.44 in their post-test scores. According to Castle et al. (2005), Garba and Muhammad (2015), differentiated instruction allows students to actively participate in observations, identifying trends and drawing conclusions based on the collected information. On one hand, the study's finding agreed to the findings of Beecher and Sweeny (2008), Carol (2005), Castle et al. (2005), Garba and Muhammad (2015); whereas on the other hand it contradicts that of Preckel and Brull (2008) who found no difference among gender using differential instruction.

Conclusion

Polytechnic students' performance in the concepts of derivative functions can be improved when differentiated instruction is adequately explored according to the findings of this study. Hence, gender has significant impact on polytechnic students' performance. Thus, male students performed better than their female counterparts in derivative functions.

Recommendations

1. It is necessary to take into account the teaching methodologies/approaches of teachers towards handling the classes. Therefore, it is recommended that teachers should explore the use of

differentiated instruction frequently as the findings revealed that the concepts of derivative functions can be improved when differentiated instruction is adequately utilized.

2. Polytechnic students should be given proper orientation about the course of derivative functions as the findings reveal that gender has significant impact on the performance of male students.

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