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DEVELOPING POLYTECHNIC STUDENTS' UNDERSTANDING OF THE CONCEPT OF INTEGRATION USING DIFFERENTIATED INSTRUCTION: A QUASI EXPERIMENTAL STUDY

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Abstract

Students learn in a variety of ways, with some lecturing, others demonstrating/discussing, and some emphasizing principles while others emphasizing applications. As a result, the level of knowledge and prior preparation of a student's learning style is affected. Anti-derivative function is used in a variety of fields, including applied problems in several disciplines. Differentiated instruction is one of the most significant ways for anti-derivative teaching because it encourages teachers to make proactive changes to curricula, teaching methods, resources, and learning activities in order to optimize learning opportunities in the classroom. This study used a quasi-experimental design in which the population was made up of all ND II students taking Calculus for Science (STP 213), and 100 students were randomly sampled. The research instruments were self-developed pre-test and post-test which are validated by experts. The instruments were pilot tested and were found reliable using Cronbach's alpha ($\alpha = 0.79$). Mean, SD, and t-test were used to statistically analyze the results. The finding shows that differentiated instruction can increase polytechnic students' understanding of integral calculus concepts. In addition, it was observed that gender has a substantial impact on polytechnic students' post-test performance.

Keywords: *Polytechnic students, integration, differentiated instruction, quasi experiment*

Introduction

Polytechnic were created to promote industrial technology, technological development, and transformation in order to act as a catalyst for both technical and societal improvements. The polytechnic system is intended to support economic transformation and can be used to address the difficulties of rising unemployment and societal crises, keeping in mind its nature. This can be realized through adding a variety of employment opportunities, particularly when large and underutilized potentials remain (Kamoru, 2021). It is self-evident that there can be no sustained economic progress in Nigeria without a good policy on polytechnic or technical education and training. The government should ensure that polytechnics have increased production and output, as well as economic diversification, value addition, and self-sufficiency (Baba, 2021). The outcome of polytechnic education is apparent to the point where the uneducated can identify if a failure occurs. Graduates of polytechnic must be appropriately educated and informed in technical education concepts as well as the application of theoretical principles because of the expectation that they can proffer long-term social and economic problems (Muhammad et al., 2020). In other to promote technology in Nigeria, it is necessary to raise the standard of educational practice in all polytechnics in order to promote technology in Nigeria (Kamoru, 2021). The supply of manpower is one of the most valuable assets a country may have in order to be successful. This means that reviewing the curriculum to satisfy this need has become increasingly important since the level of technical demand has risen dramatically over time.

Differentiated instruction is a teaching strategy in which teachers modifies curricula, teaching methods, resources, learning activities, and student outputs ahead of time to meet the diverse requirements of individual and small groups of students in order to optimize learning opportunities in the classroom (Garba & Muhammad, 2015). Differentiated instruction is a modification in teaching and learning routines that can cater to a wide range of learners' readiness levels, interests, and learning styles (Tomlinson, 2009). It is based on a teacher's basic and ongoing understanding of how teaching and learning take place, and it reacts to different learners' requirements for more structure or independence, more practice or greater challenge, and more active or less active learning ways. According to Lawrence-Brown (2004), differentiated instruction is critical for students who struggle to master the grade level material because it can help them attain two important goals (i.e. grade level standards and teachers scaffold for struggling learners). According to Alice (2011), if appropriate instructional are provided for a curriculum that is authentic and meaningful, students in a differentiated classroom setting can become more engaged, motivated, and passionate about learning. Students learn in a variety of ways, including seeing and hearing, reflecting and acting, reasoning logically and spontaneously, memorizing and visualizing, drawing comparisons and developing mathematical models, and learning in fits and starts (Garba & Muhammad, 2015). Some instructors lecture, while others exhibit or discuss; some focus on concepts, while others on applications; and some prioritize memorization while others emphasize understanding. As a result, the compatibility of the student’s learning style and the instructor’s teaching style influences the level of understanding and prior preparation. A teacher can differentiate teaching in a variety of ways in different disciplines, just as they can differentiate instruction based on a student’s preparation, learning profile, or interest by changing the material, process, or product (Garba & Muhammad, 2015). Some of the strategies used in differentiated instruction include independent projects, interest centers/groups, graded assignments, flexible grouping, learning centres, varying questions, mentoring, anchoring activities, and learning contracts.

The anti-derivative function is among the basis for the fundamental concept in calculus (Garcia et al., 2011) and is utilized in a variety of applications, including mathematical modeling of diverse circumstances in various fields such as engineering, physics, economics, and others. “Anti-derivative function is a branch of calculus that is referred to as *integral calculus* (i.e. a function whose derivative is the given function) which serves as a fundamental tool to solve problems in mathematics and physics involving the area of an arbitrary shape, the length of a curve, and the volume of a solid, among others” (Borji et al., 2018; Jones & Watson, 2018). The values of a function discovered through the integration process are known as integrals. Anti-derivative function is the process of obtaining $f(x)$ from $f'(x)$. Integrals assign numbers to functions in a way that describes displacement and motion problems, area and volume problems, and other issues that arise when small data sets are combined (Weber et al., 2012). According to Stroud (2007), "$\int f(x)\,dx$ denoted the integral of $f(x)$ with respect to the variable x; the symbol $\int$ is the integral sign, $f(x)$ is the expression to be integrated, and dx is the differential that assist in evaluating of certain integrals".

Statement of the Problem

Understanding the anti-derivative function necessitates a broad logical basis of experiences and corresponding perspectives, particularly when it comes to the concept of rate of change in real-life circumstances (Weigand, 2014). According to studies, majority of students at Nigerian higher institutions sees anti-derivative function as difficult concept to understand, assimilate, and retain. This could be associated to the fact that they have a negative attitude toward it and find it difficult to comprehend. Calculus is one of the most poorly taught and misunderstood courses in our tertiary institutions, which leads to students avoiding it (Weber et al., 2012). Differential scholastic attainment of Nigerian students has been and continues to be a subject of worry and research interest for educators, government officials, and parents. This is due to the significant impact that education has on the country's overall development. There is widespread agreement across the country that Nigeria's educational standards have declined (Adebule, 2004). Parents and the government agree that their significant investment in education is not generating the anticipated results. In this context, the the study determine the polytechnic students' understanding of integral calculus concepts through differentiated instruction.

Objectives of the Study

The objectives of the study are to:

i.Determine the effect of differentiated instruction in understanding the concept of anti-derivative functions among polytechnic students.

ii.Investigate the effect of differentiated instruction in understanding the concept of anti-derivative functions among polytechnic students with regards to gender.

Research Questions

The following research questions were raised in this study in accordance to the study's objectives:

i. Does differentiated instruction affect polytechnic students' understanding of the concept of anti-derivative functions?

ii. How does differentiated instruction affect both male and female students in understanding the concepts of anti-derivative functions?

Research Hypotheses

From the research questions, the following null hypotheses were formulated and tested at 0.05 level of significance.

Ho_1: There is no significant difference between the performances of students taught anti-derivative functions using differentiated instruction and those taught using conventional approach.

Ho_2: There is no significant difference between the mean scores of male and female students in anti-derivative functions using differentiated instruction.

Methodology

The effectiveness of differentiated instruction was tested using a quasi-experimental design with two groups (experimental and control) which are randomly distributed (Muhammad et al., 2021; White & McBurney, 2010). Before and after being exposed to a treatment, the groups were observed and analyzed in this type of study (Sani, 2017). This study was conducted in a polytechnic targeting all National Diploma II (ND II) students enrolled in a Calculus for Science (STP 213) course. Two ND II classes are randomly selected as the study samples from the institution's three collages using simple balloting process. In addition, the experimental and control groups were assigned to the designated courses using a hat-draw method. There are 100 students in total who took part in this study (56 and 44 for both experimental and control groups respectively). This number of students is sufficient for quantitative and qualitative data collection and analysis (Nieuwenhuis, 2013; Seabi, 2012). The distribution of the samples selected for the study is presented in Table 1 below.

Table 1: Samples selected for the study

S/N	Group	Program	Males	Females	Total
1	Experimental	ND II Regular program	31	25	56
2	Control	ND II Evening program	24	20	44
		Total	**55**	**45**	**100**

This study used a self-developed test as the research instrument (pre-test & post-test). Before administering the treatment, the two groups were given a pre-test to establish their level of homogeneity and understanding in the topic area. The groups were instructed separately and were given the same post-test after meeting once a week for a minimum of two hours for a period of seven weeks. Experts validated the instruments, and adjustments were made so that the instrument could be considered valid. The instruments were tested on students who were not part of the sample of the study but were part of the general population. The instrument was found to be reliable and acceptable, with a reliability coefficient of 0.79 obtained using Cronbach's alpha reliability value. As a result, any conclusions drawn from the results of this instrument are accurate judgments (Muhammad et al., 2021; Sani, 2017).

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Results

Pre-test and post-test data were obtained for this study, and the students' scores were analyzed by comparing the outcomes of the tests. In order to establish the effectiveness of differentiated instruction among polytechnic students in anti-derivative functions, the results of the tests were statistically analyze using mean, SD, and an independent t-test.

Pre-Test

Prior to the intervention, both groups were given the same pre-test to establish their level of homogeneity. As indicated in Table 2, an independent sample t-test statistic was employed to confirm if the mean pre-test scores are statistically significant.

Table 2: T-test comparison for both experimental and control groups on pre-test

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	Not Sig.
Control	44	32.75	3.09	0.51				

Independent sample t-test statistic for both experimental and control groups on their pre-test is shown in Table 2. A significant level of alpha=0.05 was used to compare the pre-test scores of both the experimental (M=33.21, SD=3.26) and control (M=32.75, SD=3.09) groups with a mean difference of 0.46. At t(98)=0.196 and p>0.001, this difference was determined to be statistically not-significant. Cohen's d for this test was 0.039, which indicates a relatively small effect size in the mean difference (Cohen, Manion & Morrison, 2017).

Post-Test

After the intervention, both groups were given the same post-test to see the effectiveness of the intervention. As indicated in Table 3, an independent sample t-test statistic was employed to confirm if the mean post-test scores are statistically significant.

Table 3: T-test comparison for both experimental and control groups on post-test

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	Sig.
Control	44	37.62	4.93	0.91				

Independent sample t-test statistic for both experimental and control groups on their post-test is shown in Table 3. A significant level of alpha=0.05 was used to compare the post-test scores of both the experimental (M=50.89, SD=4.51) and control (M=37.62, SD=4.93) groups with a mean difference of 13.27. At t(98)=13.546 and p<0.001, this difference was determined to be statistically significant. Cohen's d for this test was 3.74, which indicates a large effect size in the mean difference (Cohen et al., 2017).

Table 4: T-test comparison for gender in integral calculus scores on post-test

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

Independent sample t-test statistic for both genders on their post-test is shown in Table 4. A significant level of alpha=0.05 was used to compare the post-test scores of both male (M=52.16, SD=3.99) and female (M=43.72, SD=3.67) gender with a mean difference of 8.44. At t(98)=12.874 and p<0.001, this difference was determined to be statistically significant. Cohen's d for this test was 2.31, which indicates a large effect size in the mean difference (Cohen et al., 2017).

Discussion

According to the findings of the independent sample t-test in Table 3, differentiated instruction had a significant effect on students' understanding of anti-derivative functions among polytechnic students. The results show that the experimental group, who are taught using a differentiated instruction method, performs better than the control group, who are taught using a conventional approach. The findings revealed that differentiated instruction improves students' performance significantly by proactively modifying curricula, teaching techniques, resources, and learning activities, as well as addressing students' various needs in small groups or individually inside the classroom. It was revealed that polytechnic students were able to display differential impacts on productive disposition, conceptual knowledge, strategic competence, and adaptive thinking when differentiated instruction was used. Differentiated instruction can also enhance students' cognitive skills because they are encouraged to expand their knowledge and explore beyond what the teacher has offered. This outcome is consistent with the findings of Beecher and Sweeny (2008), Carol (2005), Castle, Deniz and Tortora (2005), Garba and Muhammad (2015), all of whom argued that a new approach to mathematics instruction will lead to improved results.

Gender was determined to have a significant effect on polytechnic students' post-test scores based on the findings of the independent sample t-test statistic from Table 4. The results show that male students performed better in anti-derivative functions than female students, with a mean difference of 8.44 in post-test scores. This is because students can understand and apply basic anti-derivative functions principles in a variety of scenarios after learning through differentiated instruction. Differentiated instruction, according to Castle et al. (2005), Garba and Muhammad (2015), allows students to actively participate in observations, discovering patterns, and making conclusions based on the data collected. On one hand, the findings of the study corresponded with those of Beecher and Sweeny (2008), Carol (2005), Castle et al.

(2005), Garba and Muhammad (2015); whereas on the other hand contradicted Preckel and Brull (2008), who reported no gender differences employing differential instruction.

Conclusion

According to the findings of this study, differentiated instruction can improve polytechnic students' understanding of anti-derivative function principles. The results reveal that the experimental group outperforms the control group due to differentiated instruction (i.e. learning through differentiated instruction enhances students' performance significantly). However, previous research has shown that students struggle to understand certain anti-derivative function principles since the concept appears abstract. This can be addressed by using differentiated instruction, which has been shown to be successful in helping students learn anti-derivative function concepts. In addition, it was observed that gender has a significant effect on polytechnic students' post-test performance. This means that in anti-derivative functions, male students outperformed their female counterparts.

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