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Research Article

Effect of Personalized Learning Strategy on Senior Secondary School Students' Achievement in Mathematics

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Abstract

The main purpose of the study is to find out the effect of personalized learning strategy on the mathematics achievement of secondary school students. The design of the study is quasi-experimental, involving pre-test, post – test non randomized control group design. Hence, two intact classes were used (59 students for experimental group while 49 students for control group). The population of this study comprised of 5221 senior secondary one (SS1) student in public secondary schools within Okigwe education zone one of Imo State, Nigeria. The sample of this study comprised 108 senior secondary one (SS1) student using stratified random sampling techniques. Trigonometry Achievement Test (TAT) which was constructed by the researcher based on the topics chosen for the study, guided by the Table of Specification. The TAT instrument was used as pre-test and after the treatments, the same instrument was re-arranged and used as post-test. The instructional tool used for teaching the students was lesson plan and the Adaptive learning platform used for Personalized learning group. The Trigonometry Achievement Test (TAT) was face and content validated by experts. The reliability co-efficient values of 0.72 was gotten which was calculated using the Kuder – Richardson Formula 20. The research questions were answered using mean and standard deviation while ANCOVA was used to test the hypotheses. The findings revealed that significant difference exists between the achievement scores of students taught mathematics with Personalized learning strategy (PLS) and traditional learning strategy. There is no significant difference in the mean achievement scores of male and female students taught mathematics using PLS. Also, the findings revealed a significant difference in the mean achievement scores of high and low students taught mathematics using PLS. Based on the findings of the results, it was recommended that lack of professional development and the overall definition of personalized learning should be tackled, learners should be allowed to reach their individual goals based on their individual levels and that consistent support for the program from Government and education administrators.

Keywords

Personalized Learning, Mathematics, Achievement, Gender and Achievement Levels

1. Introduction

Mathematics has always been as a factor in the development of a nation. The prosperity of any country depends in the volume and the quality of mathematics in its school system. The relationship which mathematics has with the society is best seen when one considers the national objectives of primary and secondary educators in relation to

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mathematics education. Eze [4] said that at different times and in different cultures and countries, mathematics education has competed to achieve a variety of different objectives. They include teaching of basic numeracy skills to all pupils, teaching of practical mathematics (arithmetic, elementary algebra, plane and solid geometry, trigonometry) to most pupils to equip them to follow a trade of craft, teaching of abstract mathematics concepts such as sets and functions at an early age, teaching of selected area of mathematics such as Euclidean geometry as an example of an axiomatic system and a model of deductive reasoning, teaching of advanced mathematics to those pupils who wish to follow a career in science, technology, engineering and mathematics (i.e. STEM) fields and teaching of heuristics (i.e. quick problem solving) and other problem solving strategies to solve non-routine problems.

The role of mathematics education in the lives of individuals and the society is very crucial. Despite the important place of mathematics in secondary school curriculum, the problem of low student achievement in mathematics has become a pervasive issue that affects students, teachers, and education systems globally. Notwithstanding, efforts to improve mathematics education, many students continue to struggle with mathematical concepts, leading to poor academic performance, decreased motivation, and limited career opportunities.

From an international perspective, the problem of low student achievement in mathematics is evident in the results of global assessments such as the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), which have consistently shown that many countries, including developed and developing nations, struggle to achieve high levels of student performance in mathematics [13]. This phenomenon has remained a source of concern to the researchers, parents, education administrators and the Nation at large.

Mathematics as a science subject is all encompassing for there is hardly any subject that does not need mathematics for its proper functioning [15]. Today, more than ever, other fields of knowledge are dependent on mathematics for solving problem, stating theories and predicting outcome. Mathematics is the backbone of science and technology and no nation can hope to achieve any measure of scientific and technological advancement without proper foundation in school mathematic [16]. Mathematics is the gateway to achieving scientific and technological advancement and economic survival.

The Federal Republic of Nigeria [5] in the National Policy on Education made mathematics one of the compulsory subjects for secondary school education. The reason is that mathematics, being the focal point of all sciences, lays the foundation for science and technology. However, science education researchers have come up with many strategies and methods for teaching science and mathematics, namely problem-solving method, inquiry – based teaching/learning approach, mathematical game and analogies as advance organizers among others [18]. Despite all these efforts, the problem of poor achievement in mathematics has continued to be noticed in some areas in like Geometry and trigonometry, according to WAEC Chief Examiners Report [24]. Based on that premise, the researcher wants to find out the application of personalized learning strategy on the secondary school students' achievement in mathematics in respect to gender and achievement levels.

Personalized learning (PL) is an instructional approach that tailors the learning experience to individual students' needs. In mathematics education, PL can potentially enhance student achievement and retention. Personalized learning involves tailoring instruction to meet individual students' needs, abilities, and learning styles [21]. This approach recognizes that students learn at different paces and in different ways, and seeks to provide customized learning experiences that cater to these differences [11]. Personalized learning also promotes deeper understanding of mathematical concepts, as students are able to learn at their own pace and explore topics in greater depth. Personalized learning is a powerful approach to mathematics education that can improve student outcomes, enhance student engagement, and provide better teacher support. By utilizing adaptive technology, flexible pacing, and real-world applications, educators can create effective personalized learning environments that support the diverse needs of their students.

Despite its benefits, implementing personalized learning in mathematics education poses several challenges. Teachers often struggle to design and deliver customized learning experiences, particularly in classrooms with diverse student populations [3]. Additionally, teachers may lack the necessary training and support to effectively integrate technology and other digital tools into their teaching practices [9]. This study is grounded in the social constructivist theory, which emphasizes the importance of social interactions and collaborative learning in shaping students' understanding of mathematical concepts [25]. Personalized learning is aligned with this theory, as it recognizes the importance of tailoring instruction to meet individual student's needs and abilities.

Numerous studies have investigated the impact of personalized learning on student achievement and retention in mathematics. For example, a study by Pane et al. [21] found that students who received personalized instruction showed significant gains in mathematics achievement compared to students who received traditional instruction. Another study by Means et al. [11] found that personalized learning was associated with increased student motivation and engagement. The implications of personalized learning for mathematics education are significant. By tailoring instruction to meet individual students' needs and abilities, teachers can promote deeper understanding of mathematical concepts and improve student achievement. Additionally, personalized learning can help to address the persistent achievement gaps that exist between different student populations.

Achievement is the feeling of getting things done as we desired or getting things that we expected. Okafor [17] described achievement as the act of accomplishing or finishing something, something accomplished successfully, especially by means of exertion, skill, practice or perseverance. It is not only reaching greater heights but also getting something after a bit of struggle, the extent to which a student, teacher or institution achieved their short or long-term educational goals is called academic achievement. Meanwhile, Academic achievement is determined by the level of accomplishment of a given task evaluated by the teacher through achievement test, assignment, etc. Adeyemi [1] describes academic achievement as the scholastic standing of a student at a given moment which states individual intellectual abilities. Achievement in mathematics therefore identifies how good or poor students have accomplished a given mathematics task or test. Thus, achievement in mathematics may not necessarily take place unless teachers form solid foundation for solid instruction through effectively planned lesson and activity- oriented techniques. This will in no small measure foster achievement, retention and mastering of the concepts in mathematics. However, improved achievement could aid the retention of mathematics concepts taught. The use of personalized learning strategy could also help both genders (male and female secondary school students) to retain mathematics concepts taught.

Gender is a socially constructed definition of men and women [20]. It is referring to the social roles that the men and women play and the power relations between them, which usually have a profound effect on the use and management of natural resources. According to Mankumari & Ajay [10], scholars, policymakers, and practitioners have observed and seem to agree upon socially constructed differences between male and female and its significant effects in their lives. Studies conducted across the world among the students studying in different levels found a significant gender difference in academic performance. Gender is not only based on sex, or the biological differences between men and women, it is being shaped by culture, social relations and natural environment [20].

Gender issue in science education has been a subject of discourse and concern to science educators. According to Onwukwe [19], science and mathematics teachers also come to class loaded with a high dosage of sex related stereotypes, which make them treat boys and girls differently. Due to sex role stereotyping, it is generally believed that mathematics is suitable for boys and not for girls. The result agreed with Ogoke, Anyanwu and Osuji, [14] who reported no significant difference in the academic achievement and retention of students in mathematics. Several studies have reported that female students outperform their male counterparts [20, 8]. Ghazvini & Khajehpour [6] further argued that even gender difference exists at the level of cognitive functioning in the academic environment. Girls are likely to be more adaptive in learning in a different environment. However, Wangu [26] in a study conducted among the students of secondary schools in Kenya observed boys passing more than girls. By implication, the method of teaching may encourage both male and female students.

In furtherance, personalized learning strategy as designed for this study could also encourage students at different achievement levels in mathematics. Achievement level has to do with different ability levels; high, average and low achievers. High-achievers are those who achieve a goal within a specified time. In school, a high-achiever would be a student who gets high marks; good grades. Low achievers have been described primarily as learners who do not perform well in the classroom [7]. They are learners who have the ability to learn necessary academic skills, but at a rate and depth below average of same age peers. Shafi [23] reported that achievement level has influence on the achievement and retention of students in mathematics when taught with cooperative learning strategy. On the contrary, Ogoke [15] found no influence of achievement levels on the academic achievement of students in mathematics when taught with cooperative and competitive learning strategies.

Against this background, personalized learning has the potential to transform mathematics education by providing customized learning experiences that cater individual students' needs and abilities. However, implementing personalized learning poses several challenges, including the need for teacher training and support. This study aims to investigate the effect of personalized learning on students' achievement and retention in mathematics, with gender and achievement levels as moderator variables with a focus on identifying effective strategies for implementing personalized learning in diverse classroom settings.

1.1. Statement of the Problem

The persistent underachievement of students in mathematics remains a significant concern in education, with many students struggling to develop a deep understanding of mathematical concepts and apply them to real-world problems. Despite efforts to improve mathematics education, achievement gaps persist, particularly among diverse student populations, gender and students with disabilities. Traditional teaching methods often fail to engage students and cater to their individual needs, leading to poor motivation and retention rates.

The one-size-fits-all approach to mathematics instruction neglects the diverse learning styles, abilities, and experiences of students, resulting in a lack of personal relevance and meaning in mathematical learning. This, in turn, can lead to decreased student interest, confidence, and overall achievement in mathematics. Furthermore, the emphasis on standardized testing and rote memorization can perpetuate a narrow and superficial understanding of mathematical concepts, rather than promoting deeper understanding and critical thinking. The consequences of mathematics underachievement are far-reaching, with students being less likely to pursue careers in science, technology, engineering, and mathematics (STEM) fields, and facing significant challenges in an increasingly complex and technologically driven world. Moreover, mathematics underachievement can have long-term effects on individuals' socio-economic opportunities and overall well-being.

In light of these challenges, there is a pressing need for innovative approaches to mathematics education that prioritize personalized learning, equity, and student-centered instruction. By addressing the diverse needs and abilities of students, educators can promote deeper understanding, motivation, and achievement in mathematics, ultimately preparing students for success in a rapidly changing world.

1.2. Purpose of the Study

The main purpose of the study is to find out the effect of personalized learning strategy on the mathematics achievement of secondary school students. Specifically, the study sought to find out the:

1) difference between the mean achievement scores of students taught Mathematics using personalized learning strategy (PLS) and traditional learning strategy (TLS).
2) difference between the mean achievement scores of students male and female taught Mathematics using PLS.
3) difference between the mean achievement scores of high and low students taught mathematics using PLS.

1.3. Research Questions

The following questions guided the study:

1) What is the difference between the mean achievement scores of students taught mathematics using PLS and TLS?
2) What is the difference between the mean achievement scores of male and female students taught mathematics using PLS?
3) What is the difference between the mean achievement scores of high and low students taught mathematics using PLS?

1.4. Hypotheses

1) There is no significant difference in mathematics achievement between students taught using PLS and TLS.
2) There is no significant difference between the mean achievement scores of male and female students taught mathematics using PLS.
3) There is no significant difference between the achievement of high and low achieving students taught using PLS.

2. Conceptual Framework

The conceptual framework showing relationship amongst variables of interest in the study on the effect of personalized learning strategy on senior secondary school students' achievement and retention in mathematics is represented in Figure 1.

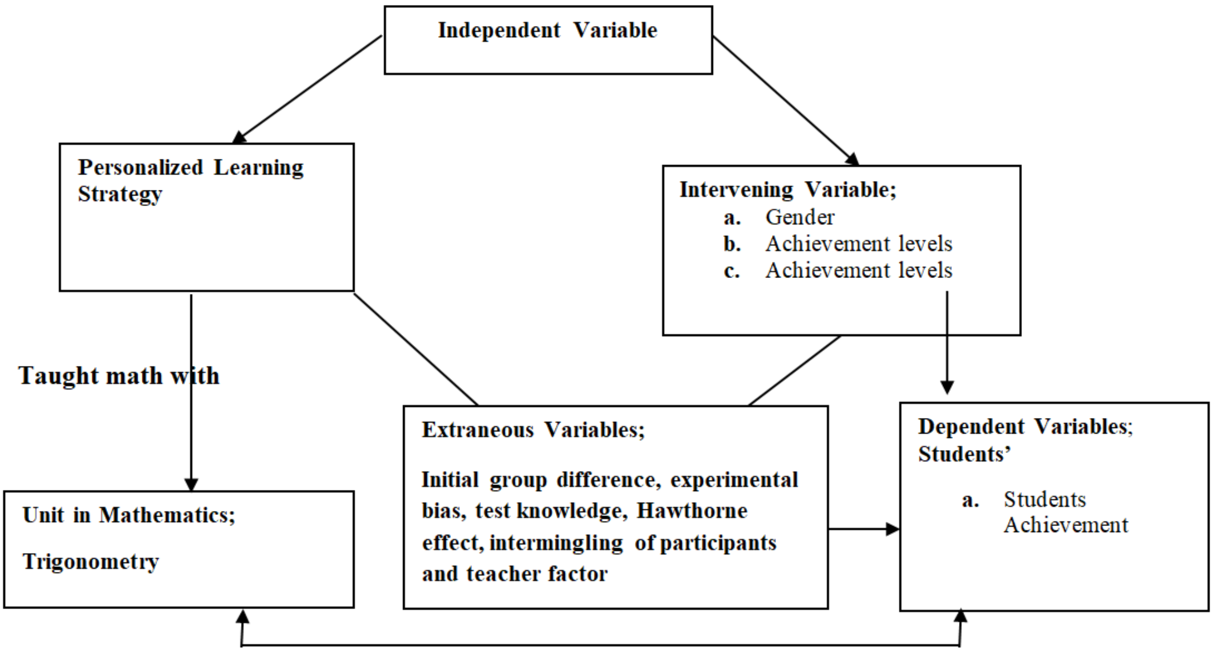

Figure 1. Schematic representation of the study concepts.

From Figure 1, the independent variable which is the Personalized Learning Strategy is manipulated. The unit of mathematics used in the manipulation is Trigonometry. The effects of the manipulation were observed in the dependent variable which is students' academic achievement. The Extraneous Variables that confounded the outcome of the study which were controlled are Initial group difference, experimental bias, test knowledge, Hawthorne effect, intermingling of participants and teacher factor. Gender and achievement levels are the intervening variables used in the study to make explicitly the relationship between the dependent and independent variables. Further, gender and achievement levels on achievement in mathematics were observed and calculated.

3. Methodology

The design of the study is quasi-experimental, involving pre-test, post – test non randomized control group design. Quasi – experimental design is defined as an experiment that does not allow the random assignment of subjects to either experimental or control group [12]. Hence, two intact classes were used (49 students for experimental group while 59 students for control group). The population of this study comprised of 5221 senior secondary one (SS1) student in public secondary schools within Okigwe education zone one of Imo State. The sample of this study comprised 108 senior secondary one (SS1) student (49 students for experimental group while 59 students for control group) within Okigwe Education zone one of Imo State using stratified random sampling techniques. One major instrument was used for collection of data in this study known as Trigonometry Achievement Test (TAT) which was constructed by the researcher based on the topics chosen for the study, guided by the Table of Specification. The TAT instrument was used as pre-test and after the treatment has been made, the same instrument was re-arranged and used as post-test. The instructional tool used for teaching the students was lesson plan and the Adaptive learning platform used for Personalized learning group. This platform uses data and Algorithms to personalized learning experience for each learner. It goes ahead to adjust the difficult level, content and pace of learning based on individual student's needs, abilities, and learning styles.

The Trigonometry Achievement Test (TAT) was face and content validated by experts. The reliability co-efficient values of 0.72 was gotten which was calculated using the Kuder – Richardson Formula 20. In order to generate achievement scores using the Trigonometry Achievement Test (TAT) instrument, the researcher adopted the pre-test and post – test technique. The pre-test TAT was administered on the participant one day before the treatment begins. Immediately after the treatment period, the same instrument (TAT) was re-arranged starting with item from the bottom and administered to the same students as post – test. The research questions were answered using mean and standard deviation while ANCOVA was used to test the hypotheses.

Implementing Personalized Learning Strategy

1) The researcher conducts initial assessments to identify students' strengths, weaknesses, and learning styles. He also continuously monitors student progress and adjust instruction accordingly.
2) The researcher creates learning profiles for each student, outlining their strengths, needs, and interests and establishes specific, measurable, achievable, relevant, and time-bound (SMART) learning goal.
3) The researcher allows students to progress at their own pace, accelerating or decelerating as needed. Provides students with choices and autonomy in their learning, such as selecting topics. Incorporates real-world applications and examples to make learning relevant and engaging.
4) The researcher utilizes adaptive technology, such as learning management systems and educational software, to support personalized learning, leverage digital resources, such as online textbooks, videos, and interactive simulations, to enhance learning.
5) The researcher regularly monitors student progress and adjust instruction accordingly. Evaluates the effectiveness of personalized learning and provide feedback to students, teachers, and parents.
6) Finally, the researcher continuously improves and refines and uses data and research to inform decision making and drive continuous improvement. Provides ongoing professional development for teachers to ensure they have the skills and knowledge needed to effectively and implement personalized learning. Continuously engages parents and the community in the personalized learning process.

4. Results

Research Question 1: What is the difference between the mean achievement scores of students taught mathematics using personalized learning and traditional learning strategy?

Table 1. *Mean and Standard Deviation of achievement scores in Pre-test and Post-test of the Treatment groups.*

Group	N	Mean Pretest Score	SD Pretest Score	Mean Posttest Score	SD Posttest Score	Mean Gain Score
PLS	59	32.41	8.75	57.90	10.66	25.49
TLS	49	31.67	9.45	50.37	12.05	18.70

From Table 1, Personalized learning strategy (PLS) group has a mean gain score in achievement of 25.49 while Traditional learning strategy (TLS) has the mean gain score of 18.70. This shows that the students in PLS group achieved higher than those in TLS group. Also, from Table 1, TLS group has the highest standard deviation score of 9.45 in pre-test and 12.05 in posttest showing that scores from that group is less homogeneous when compared to the PLS groups. In general, the table reveals that the standard deviation score for TLS group is very high in both pre-test and posttest than in PLS, which means less variability and consistency on the side of PLS.

Research Question 2: What is the difference between the mean achievement scores of male and female students taught mathematics using PLS?

Table 2. *Mean Achievement scores of male and female Students taught with PLS.*

Group	N	Mean Pre-test score	SD Pre-test score	Mean Posttest Score	SD Posttest Score	Mean Difference.
PLS						
Male	28	30.77	8.73	56.08	10.69	3.08
Female	31	33.29	9.40	53.00	12.79	

From Table 2, the mean score in achievement of male students (56.08) is higher than the mean achievement score of their female (53.00) counterparts taught mathematics with PLS with mean difference of 3.08 in favour of the male students. Table 2 further reveals that female students had higher standard deviation (SD) score than their male counterparts in PLS. In general, male students achieved higher than their female counterparts when taught with PLS.

Research Question 3: What is the difference between the mean achievement scores of high and low students taught mathematics using PLS?

Table 3. *Mean Achievement scores of high and low achieving students taught with PLS.*

Group PLS	N	Mean Pretest Score	SD Pretest Score	Mean Posttest Score	SD Posttest Score	Mean Difference
High	11	38.25	8.64	74.55	3.24	29.22
Low	15	28.60	8.18	45.33	6.17	

From Table 3, the mean score in achievement of high achieving students (74.55) is higher than the mean achievement score of their low achieving (45.33) counterparts taught mathematics using PLS, with mean difference of 29.22, in favour of the high achieving students. Table 3 further reveals that low achieving students had higher standard deviation (SD) score than their high achieving counterparts. In general, high achieving students achieved higher than their low achieving counterparts when taught with PLS.

Table 4. ANCOVA test of significant difference between mean achievements scores of Strategy, Gender and achievement levels.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12781.544[a]	12	1065.129	43.891	.000	.847
Intercept	15888.456	1	15888.456	654.720	.000	.873
PRETEST	114.588	1	114.588	4.722	.032	.047
METHOD	125.267	1	125.267	5.162	.025	.052
GENDER	39.375	1	39.375	1.623	.206	.017
ACHLEVEL	6658.861	2	3329.431	137.197	.000	.743
Error	2305.419	95	24.268			
Total	335656.000	108				
Corrected Total	15086.963	107				

a. R Squared =.847 (Adjusted R Squared =.828)

Table 4 reveals that significant difference exists between the achievement scores of students taught mathematics with Personalized learning strategy (PLS) and traditional learning strategy (TLS), F (1, 95) = 5.162, P = 0.025 < 0.05. Thus, there is a significant difference between the posttest mean achievement scores of students taught mathematics with PLS and TLS.

From the result of the ANCOVA test as shown in Table 4 also, the statement of hypothesis 2 is not rejected; implying that there is no significant difference in the mean achievement scores of male and female students taught mathematics using PLS and (1, 95) = 1.623, P = 0.206 > 0.05.

In furtherance, the result of the ANCOVA test as shown in Table 4 revealed that the statement of hypothesis 3 is rejected; implying that there is a significant difference in the mean achievement scores of high and low students taught mathematics using PLS, (1, 95) = 137.197, P = 0.000 < 0.05.

5. Discussion

The findings of the study revealed that, PLS group has a mean gain score in achievement of 25.49 while TLS has the mean gain score of 18.70. This shows that the students in PLS group achieved higher than those in TLS group. Also, from the findings as shown in Table 1, TLS group has the highest standard deviation score of 9.45 in pre-test and 12.05 in posttest showing that scores from that group is less homogeneous when compared to the PLS groups. In general, the table reveals that the standard deviation score for TLS group is very high in both pre-test and posttest than in PLS, which means less variability and consistency on the side of PLS. As a result, the findings revealed that significant difference exists between the achievement scores of students taught mathematics with Personalized learning strategy (PLS) and traditional learning strategy (TLS), F (1, 103) = 5.162, P = 0.025 < 0.05.

The study is in line with the findings [2] who discovered that personalized learning helped develop the skills of problem solving and creative thinking in our youth receiving instruction in a personalized learning classroom than those receiving instruction in a traditional classroom. In support, [27] disclosed that personalized learning did positively impact student achievement with a medium effect size for reading in his studies. However, the findings of [22] was inconclusive due to a small sample size. Whether or not personalized learning impacted student learning could not be confirmed based on the data collection at this time.

Thus, the mean score in achievement of male students is higher than the mean achievement score of their female counterparts taught mathematics with PLS with mean difference of 3.08 in favour of the male students. This means that the statement of hypothesis 2 is not rejected; implying that there is no significant difference in the mean achievement scores of male and female students taught mathematics using PLS and (1, 103) = 1.623, P = 0.206 > 0.05. The result agreed with Ogoke, Anyanwu and Osuji, [14] who reported no significant difference in the academic achievement and retention of students in mathematics. Several studies have reported that female students outperform their male counterparts [20, 8]. Ghazvini & Khajehpour [6] further argued that even gender difference exists at the level of cognitive functioning in the academic environment.

In furtherance, the findings revealed that high achieving students achieved higher than their low achieving counterparts when taught with PLS, implying that there is a significant difference in the mean achievement scores of high and low students taught mathematics using PLS, (1, 103) = 137.197, P = 0.000 < 0.05. Shafi [23] reported that achievement level has influence on the achievement and retention of students in mathematics. On the contrary, Ogoke [15] found no influence of achievement levels on the academic achievement of students in mathematics when taught with cooperative and competitive learning strategies.

5.1. Conclusion

The findings revealed that significant difference exists between the achievement scores of students taught mathematics with Personalized learning strategy (PLS) and traditional learning strategy. There is no significant difference in the mean achievement scores of male and female students taught mathematics using PLS. Also, the findings revealed a significant difference in the mean achievement scores of high and low students taught mathematics using PLS,

5.2. Recommendation

Based on the findings of the results, the following recommendations were made:

1) Lack of professional development and the overall definition of personalized learning should be tackled,
2) In the implementation of personalized learning, learners should be allowed to reach their individual goals based on their individual levels.
3) There should be consistent support for the program from Government and education administrators.

Abbreviations

PL Personalize Learning
PLS Personalize Learning Strategy
TLS Traditional Learning Strategy
TAT Trigonometry Achievement Test

Author Contributions

Ogoke Chinemeze James: Writing – original draft, Writing – review & editing
Otumegwu Tina Uchenna: Supervision, Validation
Anyanwu Anthony: Funding acquisition

Conflicts of Interest

Authors are hereby declared no conflict of interest. Also, there is no sponsorship in the cause of this study. The Authors contributed to the success of this study both financially and otherwise.

Appendix

Table 5. *Data analysis via spss.*

S/N	Pretest	Posttest	Method	Gender	Ach. Lv
1	40	72	PLS	MALE	HIGH
2	28	76	PLS	MALE	HIGH
3	20	80	PLS	MALE	HIGH
4	40	72	PLS	MALE	HIGH
5	28	76	PLS	MALE	HIGH
6	32	72	PLS	MALE	HIGH
7	40	80	PLS	FEMALE	HIGH
8	40	72	PLS	FEMALE	HIGH
9	40	72	PLS	FEMALE	HIGH
10	40	72	PLS	FEMALE	HIGH
11	48	76	PLS	FEMALE	HIGH
12	40	76	TLS	MALE	HIGH
13	40	72	TLS	MALE	HIGH
14	52	72	TLS	FEMALE	HIGH
15	32	76	TLS	FEMALE	HIGH
16	52	72	TLS	FEMALE	HIGH

S/N	Pretest	Posttest	Method	Gender	Ach. Lv
17	40	56	PLS	MALE	AVERAGE
18	36	60	PLS	MALE	AVERAGE
19	20	64	PLS	MALE	AVERAGE
20	32	60	PLS	MALE	AVERAGE
21	16	64	PLS	MALE	AVERAGE
22	36	56	PLS	MALE	AVERAGE
23	28	52	PLS	MALE	AVERAGE
24	40	60	PLS	MALE	AVERAGE
25	28	64	PLS	MALE	AVERAGE
26	16	56	PLS	MALE	AVERAGE
27	32	52	PLS	MALE	AVERAGE
28	16	54	PLS	MALE	AVERAGE
29	40	52	PLS	MALE	AVERAGE
30	36	60	PLS	MALE	AVERAGE
31	40	54	PLS	MALE	AVERAGE
32	28	52	PLS	MALE	AVERAGE
33	24	60	PLS	MALE	AVERAGE
34	32	52	PLS	MALE	AVERAGE
35	32	56	PLS	MALE	AVERAGE
36	40	60	PLS	MALE	AVERAGE
37	40	56	PLS	FEMALE	AVERAGE
38	32	64	PLS	FEMALE	AVERAGE
39	40	64	PLS	FEMALE	AVERAGE
40	40	64	PLS	FEMALE	AVERAGE
41	40	60	PLS	FEMALE	AVERAGE
42	48	60	PLS	FEMALE	AVERAGE
43	32	56	PLS	FEMALE	AVERAGE
44	40	56	PLS	FEMALE	AVERAGE
45	44	60	PLS	FEMALE	AVERAGE
46	36	52	PLS	FEMALE	AVERAGE
47	44	60	PLS	FEMALE	AVERAGE
48	20	60	PLS	FEMALE	AVERAGE
49	24	60	PLS	FEMALE	AVERAGE
50	44	52	TLS	MALE	AVERAGE
51	20	64	TLS	MALE	AVERAGE
52	32	52	TLS	MALE	AVERAGE
53	28	52	TLS	MALE	AVERAGE
54	40	52	TLS	MALE	AVERAGE
55	40	64	TLS	MALE	AVERAGE

S/N	Pretest	Posttest	Method	Gender	Ach. Lv
56	24	52	TLS	MALE	AVERAGE
57	48	64	TLS	MALE	AVERAGE
58	32	60	TLS	MALE	AVERAGE
59	40	60	TLS	FEMALE	AVERAGE
60	36	60	TLS	FEMALE	AVERAGE
61	20	52	TLS	FEMALE	AVERAGE
62	24	52	TLS	FEMALE	AVERAGE
63	32	52	TLS	FEMALE	AVERAGE
64	24	52	TLS	FEMALE	AVERAGE
65	44	60	TLS	FEMALE	AVERAGE
66	40	60	TLS	FEMALE	AVERAGE
67	32	40	TLS	FEMALE	AVERAGE
68	24	56	TLS	FEMALE	AVERAGE
69	24	56	TLS	FEMALE	AVERAGE
70	24	48	PLS	MALE	LOW
71	36	48	PLS	MALE	LOW
72	16	44	PLS	MALE	LOW
73	36	48	PLS	FEMALE	LOW
74	44	48	PLS	FEMALE	LOW
75	28	44	PLS	FEMALE	LOW
76	20	48	PLS	FEMALE	LOW
77	36	44	PLS	FEMALE	LOW
78	24	48	PLS	FEMALE	LOW
79	20	48	PLS	FEMALE	LOW
80	16	24	PLS	FEMALE	LOW
81	32	48	PLS	FEMALE	LOW
82	32	44	PLS	FEMALE	LOW
83	28	48	PLS	FEMALE	LOW
84	32	48	PLS	FEMALE	LOW
85	28	40	TLS	MALE	LOW
86	20	40	TLS	MALE	LOW
87	20	48	TLS	MALE	LOW
88	28	44	TLS	MALE	LOW
89	20	40	TLS	MALE	LOW
90	16	44	TLS	MALE	LOW
91	40	48	TLS	MALE	LOW
92	32	48	TLS	MALE	LOW
93	32	48	TLS	MALE	LOW
94	40	48	TLS	MALE	LOW

S/N	Pretest	Posttest	Method	Gender	Ach. Lv
95	40	44	TLS	MALE	LOW
96	20	32	TLS	MALE	LOW
97	40	48	TLS	FEMALE	LOW
98	24	44	TLS	FEMALE	LOW
99	40	40	TLS	FEMALE	LOW
100	24	32	TLS	FEMALE	LOW
101	32	48	TLS	FEMALE	LOW
102	24	40	TLS	FEMALE	LOW
103	20	40	TLS	FEMALE	LOW
104	36	40	TLS	FEMALE	LOW
105	24	32	TLS	FEMALE	LOW
106	40	32	TLS	FEMALE	LOW
107	32	44	TLS	FEMALE	LOW
108	16	24	TLS	FEMALE	LOW

Table 6. *Pretest posttest * method.*

Method		Pretest	Posttest
PLS	Mean	32.4068	57.8983
	N	59	59
	Std. Deviation	8.74765	10.66366
TLS	Mean	31.6735	50.3673
	N	49	49
	Std. Deviation	9.44587	12.05317
Total	Mean	32.0741	54.4815
	N	108	108
	Std. Deviation	9.03545	11.87433

Table 7. *Pretest posttest * gender.*

Gender		Pretest	Posttest
MALE	Mean	30.7692	56.0769
	N	52	52
	Std. Deviation	8.73266	10.69331
FEMALE	Mean	33.2857	53.0000
	N	56	56
	Std. Deviation	9.21997	12.79204
Total	Mean	32.0741	54.4815

Gender		Pretest	Posttest
	N	108	108
	Std. Deviation	9.03545	11.87433

*Table 8. PRETEST POSTTEST * ACHLEVEMENT LEVELS.*

ACHLEVEL		PRETEST	POSTTEST
HIGH	Mean	38.2500	74.2500
	N	16	16
	Std. Deviation	8.63713	2.90975
AVERAGE	Mean	32.8462	57.4615
	N	52	52
	Std. Deviation	8.72541	4.39457
LOW	Mean	28.6000	42.7000
	N	40	40
	Std. Deviation	8.18003	6.61854
Total	Mean	32.0741	54.4815
	N	108	108
	Std. Deviation	9.03545	11.87433

Table 9. Between-Subjects Factors.

		Value Label	N
METHOD	1.00	PLS	59
	2.00	TLS	49
GENDER	4.00	MALE	52
	5.00	FEMALE	56
ACHLEVEL	6.00	HIGH	16
	7.00	AVERAGE	52
	8.00	LOW	40

Table 10. Descriptive Statistics - Dependent Variable: POSTTEST.

METHOD	GENDER	ACHLEVEL	Mean	Std. Deviation	N
PLS	MALE	HIGH	74.6667	3.26599	6
		AVERAGE	57.2000	4.27477	20
		LOW	46.6667	2.30940	3
		Total	59.7241	9.23849	29

METHOD	GENDER	ACHLEVEL	Mean	Std. Deviation	N
	FEMALE	HIGH	74.4000	3.57771	5
		AVERAGE	59.3846	3.59487	13
		LOW	45.0000	6.84902	12
		Total	56.1333	11.76709	30
	Total	HIGH	74.5455	3.23616	11
		AVERAGE	58.0606	4.10746	33
		LOW	45.3333	6.17213	15
		Total	57.8983	10.66366	59
TLS	MALE	HIGH	74.0000	2.82843	2
		AVERAGE	56.8889	5.92546	9
		LOW	43.6667	4.96045	12
		Total	51.4783	10.80770	23
	FEMALE	HIGH	73.3333	2.30940	3
		AVERAGE	56.0000	3.77124	10
		LOW	38.7692	7.00183	13
		Total	49.3846	13.19114	26
	Total	HIGH	73.6000	2.19089	5
		AVERAGE	56.4211	4.78790	19
		LOW	41.1200	6.48280	25
		Total	50.3673	12.05317	49
Total	MALE	HIGH	74.5000	2.97610	8
		AVERAGE	57.1034	4.73848	29
		LOW	44.2667	4.65168	15
		Total	56.0769	10.69331	52
	FEMALE	HIGH	74.0000	3.02372	8
		AVERAGE	57.9130	3.97621	23
		LOW	41.7600	7.49044	25
		Total	53.0000	12.79204	56
	Total	HIGH	74.2500	2.90975	16
		AVERAGE	57.4615	4.39457	52
		LOW	42.7000	6.61854	40
		Total	54.4815	11.87433	108

Table 11. *Tests of Between-Subjects Effects - Dependent Variable: POSTTEST.*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12781.544[a]	12	1065.129	43.891	.000	.847
Intercept	15888.456	1	15888.456	654.720	.000	.873

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PRETEST	114.588	1	114.588	4.722	.032	.047
METHOD	125.267	1	125.267	5.162	.025	.052
GENDER	39.375	1	39.375	1.623	.206	.017
ACHLEVEL	6658.861	2	3329.431	137.197	.000	.743
METHOD * GENDER	9.404	1	9.404	.388	.535	.004
METHOD * ACHLEVEL	46.935	2	23.467	.967	.384	.020
GENDER * ACHLEVEL	73.230	2	36.615	1.509	.226	.031
METHOD * GENDER * ACHLEVEL	5.769	2	2.884	.119	.888	.002
Error	2305.419	95	24.268			
Total	335656.000	108				
Corrected Total	15086.963	107				

a. R Squared =.847 (Adjusted R Squared =.828)

Estimated Marginal Means

Table 12. Grand Mean - Dependent Variable: POSTTEST.

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
58.137[a]	.604	56.939	59.336

a. Covariates appearing in the model are evaluated at the following values: PRETEST = 32.0741.

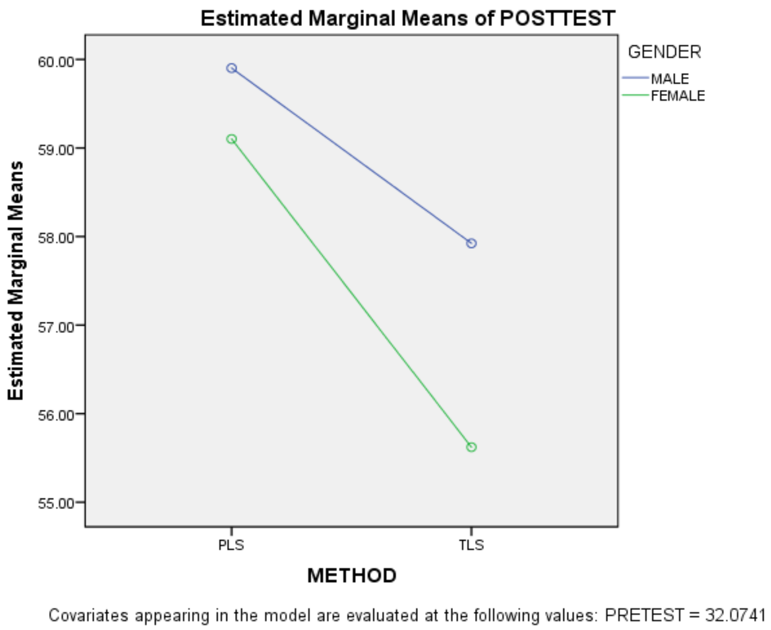

Figure 2. Profile Plots.

Table 13. *Between-Subjects Factors.*

		Value Label	N
METHOD	1.00	PLS	59
GENDER	4.00	MALE	29
	5.00	FEMALE	30
ACHLEVEL	6.00	HIGH	11
	7.00	AVERAGE	33
	8.00	LOW	15

Table 14. *Descriptive Statistics - Dependent Variable: POSTTEST.*

METHOD	GENDER	ACHLEVEL	Mean	Std. Deviation	N
PLS	MALE	HIGH	74.6667	3.26599	6
		AVERAGE	57.2000	4.27477	20
		LOW	46.6667	2.30940	3
		Total	59.7241	9.23849	29
	FEMALE	HIGH	74.4000	3.57771	5
		AVERAGE	59.3846	3.59487	13
		LOW	45.0000	6.84902	12
		Total	56.1333	11.76709	30
	Total	HIGH	74.5455	3.23616	11
		AVERAGE	58.0606	4.10746	33
		LOW	45.3333	6.17213	15
		Total	57.8983	10.66366	59
Total	MALE	HIGH	74.6667	3.26599	6
		AVERAGE	57.2000	4.27477	20
		LOW	46.6667	2.30940	3
		Total	59.7241	9.23849	29
	FEMALE	HIGH	74.4000	3.57771	5
		AVERAGE	59.3846	3.59487	13
		LOW	45.0000	6.84902	12
		Total	56.1333	11.76709	30
	Total	HIGH	74.5455	3.23616	11
		AVERAGE	58.0606	4.10746	33
		LOW	45.3333	6.17213	15
		Total	57.8983	10.66366	59

Table 15. *Tests of Between-Subjects Effects - Dependent Variable: POSTTEST.*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5463.519[a]	6	910.587	41.834	.000	.828
Intercept	10297.263	1	10297.263	473.073	.000	.901
PRETEST	1.606	1	1.606	.074	.787	.001
METHOD	.000	0	.	.	.	.000
GENDER	.035	1	.035	.002	.968	.000
ACHLEVEL	3813.289	2	1906.644	87.594	.000	.771
METHOD * GENDER	.000	0	.	.	.	.000
METHOD * ACHLEVEL	.000	0	.	.	.	.000
GENDER * ACHLEVEL	32.349	2	16.175	.743	.481	.028
METHOD * GENDER * ACHLEVEL	.000	0	.	.	.	.000
Error	1131.870	52	21.767			
Total	204376.000	59				
Corrected Total	6595.390	58				

a. R Squared =.828 (Adjusted R Squared =.809)

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