Effect of personalized instructional strategy on student achievement in mathematics

Abiodun, T. O
Department of Mathematics, Tai Solarin University of Education. Ijagun, Ogun-State, Nigeria.

Asanre, A. A.
Department of MSTE, University of Zululand, South Africa.

Arigbabu, A. I.
Department of STED, Olabisi Onabanjo University. Ago Iwoye. Ogun State, Nigeria.

Adebiyi, L. A.
Emmanuel Alayande University of Education, Nigeria

Corresponding Author: abiodunto@tasued.edu.ng

Abstract
The study examined how the personalized learning strategy affected mathematics students' academic performance. This study used a quasi-experimental, non-randomized pretest-posttest control group design. The population included every SS 2 student enrolled in Ogun's Central Senatorial District in Ogun State, Nigeria. From four local government areas in the Ogun-East Senatorial District, two treatment classes (62 students) and two control classes (68 students) were chosen at random. Samples were drawn using a simple random sampling technique. Using a pre-test-post-test quasi-experimental research design, the study was guided by two research questions and two null research hypotheses. The Guttman split-half method was used to evaluate instrument reliability, yielding a coefficient of 0.86. At the 0.05 level of significance, the data were analyzed using descriptive statistics (mean and standard deviation) and inferential statistics (independent-samples t-test). The results showed that students' achievement in mathematics improved when the teacher used a personalized instructional strategy. Additionally, the findings revealed no significant difference in the performance of male and female students when mathematics was taught using the personalized learning approach.
Keywords: Achievement, Personalized, Strategy, Students.

Introduction

Mathematics is a required subject for all students in Nigeria at the basic and secondary school levels and is part of the secondary school curriculum (FRN, 2013). The development of analytical and critical thinking abilities, essential in subjects like science, technology, engineering, and mathematics (STEM), depends heavily on mathematics education. However, Nigerian students' performance in mathematics remains a concern, as shown by consistently poor pass rates on standardized tests like the West African Senior School Certificate

Examination (WASSCE) (Prince & Felder, 2016). This poor performance stems from several problems, including a shortage of trained teachers, inadequate teaching resources, and conventional teaching strategies that fail to engage students (Romiro, 2021). To overcome these obstacles, educators have advocated for more student-centered and interactive teaching methods that can improve students' comprehension and enthusiasm for mathematics (Abiodun, Asanre & Chinaka, 2025). Implicitly, mathematics provides students with fundamental numeracy skills necessary to function well in society.

Numerous variables, such as motivation, attitude, and teaching methods, are linked to students' poor performance in mathematics (Abiodun et al., 2022). According to Abdullahi (2021), students' low performance in mathematics stems from their inability to acquire the knowledge and skills needed to contribute significantly to science and technology. For instance, the annual mathematics report from the Chief Examiners of the West African Examination Council (WAEC) (WAEC, 2019–2024) showed that secondary school students scored poorly in mathematics. Therefore, it is necessary to determine the reason for the poor performance in this subject. Because it accommodates diverse student characteristics, a personalized strategy may help explain students' low mathematics performance; however, research indicates that this instructional approach is underutilized and understudied (Bates & Wiest, 2004). This study aimed to test the idea of personalized learning by examining more frequently overlooked aspects, such as gender differences and the extent to which it is used to improve students' performance. Because no research has been conducted in the senatorial district, the study focused on Ogun Central.

Personalized instructional strategies have become increasingly important in mathematics education because they recognize that students differ in their prior knowledge, learning pace, interests, and preferred ways of learning. Unlike the traditional approach, personalized instruction adapts teaching methods, learning activities, and assessment to meet individual learners' needs. This approach encourages students to take an active role in their learning while teachers provide appropriate support and feedback. Recent educational research suggests that personalized instruction enhances students' conceptual understanding, motivation, confidence, and academic achievement in mathematics. According to Bartolomé, Castañeda, and Adell (2018), the goal of personalization in the educational system is to tailor the teaching and learning process by developing an adaptable framework that meets each student's unique needs. According to Shemshack and Spector (2020), learning is the growth of an individual's knowledge and skills, a basic human activity shaped by individual experiences, information-processing capacity, attitudes, and surroundings. Personal experiences and social interactions help people learn (Shemshack & Spector, 2020). The underlying premise of personalized learning is that every student is different and has a unique learning style (Nandigam, Tirumala & Baghaei, 2014).

The goal of personalized learning in education is to adjust the learning process to each student's unique needs, goals, and skills. This can be accomplished by using modern instructional strategies that provide unique learning opportunities across a range of learning contexts (Shemshack et al., 2021). According to Tadlaoui and Khaldi (2020), personalised learning should develop knowledge, skills, behaviours, and strategies that are relevant and meaningful to the learner and inspire them to pursue further education. Three fundamental components define personalised learning: how learning materials and content are delivered to students, how learning activities are paced and sequenced to match learners' progress, and the system's guidance or support to help learners reach their objectives.

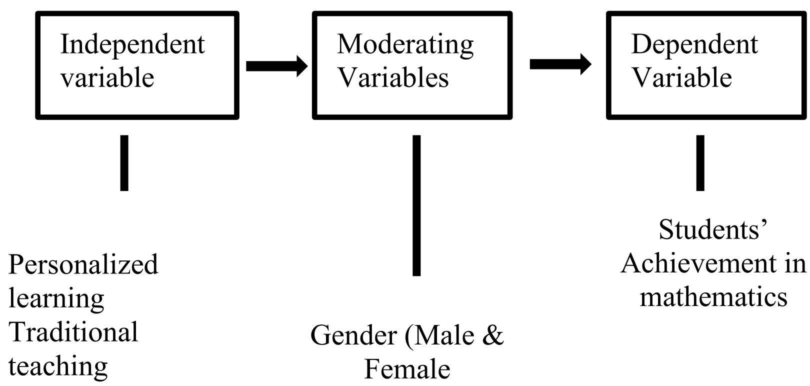
Due to major developments in education, there has been a discernible increase in the use and integration of individualized learning approaches in recent years (Pantziara & Philippou, 2012). Walkington and Bernacki (2020) assert that personalized learning is more than just an instructional strategy; it is a comprehensive approach that aims to customize the entire learning ecosystem to meet the unique needs of students by utilizing the collective knowledge of educators and learners as well as well-established learning theories (such as behaviorist, cognitivist, or constructivist perspectives). By utilizing the revolutionary potential of state-of-the-art instructional technology, personalized learning essentially aims to offer customized learning experiences that are suited to each learner's particular requirements, goals, and capabilities (Shemshack et al., 2021). Although researchers have worked hard to define and clarify personalized learning, there are still a number of implementation models that make it difficult to define precisely (Simpson, 2020). This flexibility is a problem for researchers trying to evaluate its advantages because different definitions and uses of personalization make it difficult to analyze how it affects students' academic performance and educational experiences (Walkington & Bernacki, 2020; Halverson, 2019). Personalized learning environments frequently include competency-based pedagogies, the strategic use of personalization, the adoption of multiple instructional modalities, the empowerment of learner voice and choice, and the flexible distribution of temporal and physical resources (Simpson, 2020; Groff, 2017). Personalized learning is an essential component of education worldwide; it is not a new idea. It has significantly expanded opportunities for personalized mathematics instruction. Personalized learning can monitor students' progress, identify misconceptions, and recommend learning activities tailored to individual needs. In a large-scale study involving middle school students, Nitkin et al. (2022) found that personalized mathematics instruction created individualized learning experiences that improved students' engagement and learning outcomes. Although implementation challenges such as scheduling and school policies existed, personalized learning allowed students to receive instruction that matched their academic readiness, leading to improved mathematics performance.

In traditional classrooms, teachers often adapt their pedagogical strategies to challenge high performers and provide focused support to struggling students. Current literature offers numerous recommendations supporting the efficacy of customized learning interventions. Extensive empirical research by Chien et al. (2016) and Hunsu et al. (2016) has shown the transformative potential of educational strategies tailored to specific students' needs. Technology-enabled individualized learning programs have produced statistically significant, somewhat beneficial learning outcomes in economically disadvantaged environments (Major et al., 2021). Regardless of the level of teacher participation in the personalization process, these interventions have shown strong effectiveness in literacy and mathematics. Additionally, Falcão et al. (2018) found that individualized learning can boost student motivation, increase engagement, and promote deeper comprehension. It may maximize overall efficacy, learning efficiency, and learner satisfaction (Fabregat Gesa et al., 2014). Personalized learning encompasses a variety of programs that aim to address the different learning needs and interests of students from diverse backgrounds. At the same time, students' search for understanding motivates them to learn better. The following components of personalized learning were examined: student choice, student engagement, flexible learning environment, and personal learning paths (McLeskey, Rosenberg & Westling, 2017). When students want to know more about an idea, a topic, or an entire subject, they put more cognitive energy into classroom investigations and discussions and study more on their own. Thus, the elements of the teaching-learning process must be flexible yet interactive in a constructive learning environment (Bolstad et al., 2012).

Gender plays an important role in education, impacting students' learning and performance in a variety of areas. Research links gender disparities in learning outcomes and experiences to socialization patterns, cognitive capacities, and learning styles (Hyde, 2016). Research also suggests that male and female students may respond differently to certain teaching modalities. According to Kollosche, Steflitsch, and Daweis-Weidlinger (2024), research indicates that female students may do better in collaborative and discussion-based settings, whereas male students may gain more from competitive and hands-on activities. These variations show how crucial it is to consider gender when implementing instructional strategies like personalized learning to ensure every student receives the same level of support. Research examining the efficacy of personalized instructional strategies across various student groups was necessary because of ongoing difficulties in Nigerian mathematics education and the possible influence of gender on learning outcomes.

Vygotsky's (1978) social constructivist theory of learning served as the foundation of this study. According to Vygotsky, students must actively participate in creative activities and self-organization for learning to occur. Teachers should encourage their students to formulate their own ideas, ask questions, and test them for feasibility. In mathematics classrooms, teachers implementing personalized instruction often adjust lesson difficulty, provide multiple learning pathways, integrate digital technologies, and offer continuous formative assessment. These practices enable students to learn according to their readiness levels and learning profiles rather than following a uniform instructional sequence. Zhang et al. (2022) emphasized that effective personalized learning integrates Universal Design for Learning (UDL) principles, ensuring students have multiple means of engagement, representation, and expression. This inclusive approach helps learners with diverse abilities participate successfully in mathematics learning. Figure 1 shows the study's conceptual framework.

Figure 1: The conceptual framework of personalized instruction on student achievement in mathematics.



Methods

This study used a quasi-experimental, non-randomized pretest-posttest control group design. The population included all SS 2 students enrolled in Ogun's Central Senatorial District in Ogun State, Nigeria. From four local government areas in the Ogun-East Senatorial District, two treatment classes (with 62 students) and two control classes (with 68 students) were chosen at random. The researchers selected samples from the chosen classes in the four schools using simple random sampling. Primary data were collected using the Mathematics Achievement Test (MAT). The MAT consists of fifty objective, multiple-choice questions. The questions were obtained from the National Examination Council (NECO), the West African Examination Council (WAEC), and the National Business and Technical Examinations Board (NABTEB) from 2022–2025. Three experts from the Department of Science and Technology Education (Measurement and Evaluation Unit), Olabisi Onabanjo University, Ago-Iwoye, and the Department of Mathematics Education (Mathematics Education Unit), Tai Solarin Federal University of Education, Ijagun, Ogun State, validated the instruments. The researchers assessed MAT's reliability using the Kuder-Richardson 20 formula, yielding a reliability coefficient of 0.86. The researchers trained normal mathematics teachers in the schools under study to serve as research assistants. The researchers and research assistants used personalized teaching to instruct the experimental group using the personalized lesson plan they created. In contrast, the researchers developed lesson plans that mirrored the learning objectives of the personalized teaching counterpart and used the normal lecture method (LM) to teach the control group. The actual treatment lasted five weeks in each school. The study used means and standard deviations to answer the research questions, and an independent t-test to test the hypotheses at the 0.05 level of significance. All procedures followed the schools' ethical standards. Initially, the sampled schools were asked for permission to use the class. Before students were exposed to the treatment, the pre-treatment phase (pre-test) evaluated their starting mathematical performance in both the control and experimental groups. Following the pre-treatment phase, the treatment phase introduced students in both groups to the study's main topics, including simultaneous linear equations, probability, trigonometry, and sequences and series. Both the experimental (Personalized instructional strategy) and control (lecture method) groups received MAT during the post-treatment phase, which also included the post-test phase. To answer the study questions, the mean and standard deviation of the pre-test and post-test data were statistically analyzed. At the 0.05 level of significance, the independent-samples t-test was used to test the null hypotheses. Table 1 shows the research design.

Table 1. Design of research

Experimental Group	RO1	X1	RO3
Control Group	RO2	X2	RO4

Where RO1 and RO2 are pretests in the experimental and control groups; RO3 and RO4 are posttests in the experimental and control groups; X1 and X2 are the treatments in the experimental and control groups, respectively.

The study was guided by the following research question: (i) What are the mean achievement scores of the students exposed to the experimental and control strategies? (ii) What are the differences between the mean mathematics scores of male and female students in the experimental group? Furthermore, at the significance level of 0.05, the following research hypotheses were examined: (i) the mean achievement scores of students who received mathematics instruction using the personalized learning strategy and those who received it using the conventional method did not differ significantly; (ii) the mean achievement scores of male and female students who received mathematics instruction using the personalized learning strategy did not differ significantly.

Findings and Discussion

Findings

The results of the data analysed and descriptive statistics for this study are presented in tables, and the results of the hypotheses tested are presented in their respective Tables.

Table 2. The descriptive statistics of the respondents on gender, numbers, and percentages

Group	Gender	Number of participants	Percentages
Experimental	Male	30	23.1
	Female	32	24.6
Control	Male	29	22.3
	Female	39	30.0
Total	130	130	100

Table 2 shows that 130 students participated in the study. In the experimental group, 30 respondents were male (23.1%), and 32 respondents were female (24.6%). In the control group, 29 respondents were male (22.3%), and 39 were female (30%). This suggested that more female students than male students took part in the study.

Research question one: What is the mean achievement score of the students exposed to experimental and control strategies?

Table 3. Summary of mean and standard deviation of Students in the experimental and control groups

Group	Test	Number	Mean	Standard deviation
Experimental	Pretest	62	20.47	3.472
	Posttest	62	34.26	4.995
Control	Pretest	68	21.34	3.715
	Posttest	68	21.82	4.747

According to Table 3, students taught mathematics using the personalized learning strategy had a mean pretest score of 20.47 (SD = 3.472). In contrast, students taught mathematics using the personalized learning strategy had a mean posttest score of 34.26 (SD = 4.995). Similarly, students taught using the lecture method had a mean pretest score of 21.34, with a standard deviation of 3.715. Students taught mathematics using the lecture strategy had a mean posttest score of 21.82 and a standard deviation of 4.747. Compared to the control groups, the personalized learning technique yielded a larger mean gain.

Research Question two: What are the differences between the mean mathematics scores of male and female students in the experimental group?

Table 4: Mean and Standard Deviation of personalized learning method based on gender of students in mathematics before and after treatment

Group	Test	Number	Mean	Standard deviation
Male	Pretest	30	19.57	3.674
	Posttest	30	34.33	4.866
Female	Pretest	32	22.28	5.786
	Posttest	32	33.56	4.747

According to Table 4, the pre-test mean mathematics scores for male and female students exposed to the personalized learning technique were 19.57 and 22.33, respectively, with standard deviations of 3.674 and 5.786. Following treatment, the mean mathematics scores for male and female students were 34.33 and 33.56, respectively, with standard deviations of 4.866 and 4.747. The mean gain differential for female students was 0.77.

Hypothesis One: The mean achievement scores of students who were taught mathematics using the personalized learning strategy and those who were taught the subject through lectures did not differ significantly.

Table 5. Independent t-test analysis of students' achievement scores in the flipped classroom learning strategy class and the lecture method class.

Strategies	Mean	Std. Dev.	Df	Mean Difference	95% confidence interval of the difference		T	Sig.
					Lower	Upper		
Personalized learning method	34.10	5.368	128	12.111	10.336	13.887	13.479	0.00
Lecture method	21.99	4.864		12.111	10.327	13.896		

Table 5 shows students' academic performance in the control class (lecture technique) and the experimental class. After the intervention, the experimental class outperformed the control group in mathematics (Mean = 34.10; Std. Dev = 5.368). Furthermore, the mean difference for the experimental group was 12.111 (95% CI [10.336 to 13.887]). Likewise, the control group's mean difference was 12.111 95% CI [10.327 to 13.896]. Students' mathematics achievement levels also differed significantly after the intervention, as shown in Table 4 ($t = 13.479$, $df = 128$; $p = 0.000 < 0.05$). The results show a significant difference in mean achievement scores between students who received mathematics instruction through lectures and those who used the personalized learning approach.

Hypothesis two: The mean achievement scores of male and female students who were taught mathematics using the personalized learning strategy did not differ significantly

Table 6: Independent t-test analysis of students' achievement scores in the personalized learning strategy class based on their gender.

Gender	Mean	Std. Dev.	df	Mean Difference	95% confidence interval of the difference		T	Sig.
					Lower	Upper		
Male	34.27	5.443		1.296	-3.982	1.391	0.965	0.338
Female	35.45	5.130	60	1.296	-3.988	1.397		

Table 6 shows a gender-based analysis of students' academic achievement in the experimental class. After the intervention, there was no significant gender difference in mathematics achievement in the experimental class. For the male group, the mean difference was 1.296, 95% CI [-3.982 to 1.391], while for the female group, it was 1.296, 95% CI [-3.988 to 1.397]. After the intervention, students' mathematics achievement did not differ significantly by gender (Table 6; $t = 0.965$, $df = 60$; $p = 0.338 > 0.05$).

Discussion

This result showed that, when compared to the conventional teaching method, implementing personalized instruction greatly increased students' mathematical achievement. This outcome supported earlier studies that connected learner-centered teaching strategies to improved students' learning and achievement (Abiodun & Asanre, 2025; Abiodun, 2024; Asanre & Abiodun, 2025; Awofala, 2016). These findings also imply that when instruction is tailored to students' diverse abilities, readiness levels, and learning preferences, students demonstrate improved comprehension and academic achievement in mathematics. This result also corroborates Romiro's (2021) findings on the impact of personalized instruction on students' academic performance in physics. Students who received personalized instruction and were exposed to a positive learning environment performed better academically in physics. Additionally, the study's results support Patall, Cooper, and Wynn (2010), who claimed that students with a choice in their homework assignments are more engaged, enthusiastic, and proficient in mathematics. The results also align with Awofala's (2014) findings, which showed that students receiving individualized instruction had lower anxiety about numeracy word problems but higher self-confidence, liking, usefulness, and motivation than students in the non-personalized group. A systematic review by Setambah et al. (2025) found that personalized instructional in mathematics consistently improved students' achievement, motivation, and classroom participation. The review highlighted collaborative learning, technology integration, flexible grouping, and learner-centered instruction as essential components of effective personalized mathematics teaching. Another important dimension of personalized instruction is web-based and digital mathematics learning. A meta-analysis by Akın (2022) showed that web-based mathematics instruction, particularly when personalized to students' learning needs, significantly improved mathematics achievement across educational levels. The study suggested that personalized online learning environments provide immediate feedback, individualized practice opportunities, and adaptive learning sequences that support students' mathematical development.

The results showed that achievement depends on the individual student, not gender, and that both boys and girls benefited equally from tailored learning. This finding is consistent with Akinsola and Awofala (2009), who found that gender differences and the use of individualized print-based instruction substantially affected the performance of 320 senior secondary students in Nigeria. It also suggests that PL can improve students' academic performance regardless of gender. This is consistent with a study by Bates and Wiest (2004) that, aside from students' positive opinions, found no significant differences between the sexes and that customization had no effect on achievement. Additionally, Akinsola & Awofala (2009) found no discernible gender difference. Both male and female students are similarly impacted by the personalized teaching approach.

Conclusion

The findings of this study revealed that personalized instructional strategies play a significant role in improving students' achievement in mathematics. By recognizing and responding to individual differences in learners' abilities, interests, learning pace, and academic needs, these strategies create a more engaging and supportive learning environment. As a result, students become more actively involved in the learning process, develop greater confidence in solving mathematical problems, and achieve better academic outcomes. The findings suggest that tailoring instruction to students' unique learning needs enhances understanding and promotes meaningful learning, leading to improved performance in mathematics. Furthermore, the study found that personalized instructional strategies are equally effective for both genders. Both male and female students benefited equally from the instructional approach, indicating that personalized learning provides equal opportunities for academic success regardless of gender. This finding highlights the inclusive nature of personalized instruction and suggests it can be implemented effectively in diverse classroom settings without creating gender-based achievement disparities. Hence, the study concludes that personalized instructional strategies are an effective and equitable approach to improving mathematics achievement. Adopting them in mathematics classrooms can improve learning outcomes while ensuring that all students, regardless of gender, have the opportunity to reach their full academic potential.

Acknowledgement

The author expresses sincere gratitude to the students and schools that participated in the survey. They also thank all the research assistants involved in the study.

References

Abdullahi, A. C., Jibrin, A. G., Dauda, M. O. & Danjuma I. M. (2021). Effect of 7es learning strategy on retention secondary school students in Biology in Bauchi Metropolis, Bauchi State, Nigeria. *Global Journal of Education, Humanities and Management Sciences* 3(1), 125 – 136.

Abiodun, T. O. (2024). Effects of problem-based learning strategy on secondary school mathematics students' academic achievement in Ogun State, Nigeria. *African Journal of Science Technology and Mathematics Education*. 10(2), 246-251. https://www.ajstme.com.ng

Abiodun, T.O. & Asanre, A.A. (2025). Effects of computer assisted instruction (CAI) on senior secondary school students' learning outcome in mathematics. *African Journal of Science Technology and Mathematics Education*. 11(1) 171-177. https://www.ajstme.com.ng

Abiodun, T.O., Asanre, A.A. & Chinaka, T.W. (2025). Impact of the elicit, engage, explore, explain, elaborate, evaluate and extend (7E) learning model on Senior Secondary school students' mathematics achievement. *ASEAN Jornal of Science and Engineering Education.* 5(2), 117-126. http://ejournal.upi/index.php/AJSEE/

Abiodun, T.O., Asanre, A.A., Ogundeji, M.A., Odupe, T.A & Rasaki, M.G (2022): Influence of teachers' characteristics on students' achievement in mathematics in Ogun State, Nigeria. *Journal of Science, Technology and Education (JSTE)*; www.nsukjste.com/6(3), 16-22.

Akın, A. (2022). The effectiveness of web-based mathematics instruction on K–16 students' mathematics learning: A meta-analytic research. *Education and Information Technologies*, 27, 8015–8040. DOI: 10.1007/s10639-022-10931-x

Akinsola, M. K. & Awofala, A. O. A. (2009). Effect of personalization of instruction on pupils' achievement and self-efficacy in numeracy word problems. *International Journal of Mathematical Education in Science and Technology*, 40(3), 389-404. Doi: 10.1080/00207390802643169

Asanre, A. A., & Abiodun T. O. (2025). Effect of laboratory teaching strategy on academic performance of primary school students in mathematics. *Journal of Educational Sciences*. 9(1),409-416. Doi: 10.31258/jes.9.1.p.409-418

Awofala, A. O.A. (2014). Examining personalisation of instruction, attitudes toward and achievement in numeracy word problems among Nigerian senior secondary school pupils. *International Journal of Education in Numeracy, Science and Technology*, 2(4), 273-288. Doi: 10.18404/ijemst.91464

Bartolomé, A., Castañeda, L. & Adell, J. (2018). Personalisation in educational technology: the absence of underlying pedagogies. *International Journal of Educational Technology in Higher Education*, 15(1), 1–17. Doi: 10.1186/s41239-018-0095-0

Bates, E. T., & Wiest, L. R. (2004). Impact of personalization of mathematical word problems on student performance. *The Mathematics Educator*, 14(2), 17-26. Doi: 10.63301/tme.v14i2.1876

Bolstad, R., Gilbert, J., McDowall, S., Bull, A., Boyd, S., & Hipkins, R. (2012). Supporting future oriented learning and teaching - a New Zealand perspective. New Zealand: Ministry of Education

Chien, Y. T., Chang, Y. H., & Chang, C. Y. (2016). Do we click in the right way? A meta-analytic review of clicker-integrated instruction. *Educational Research Review*, 17(1), 1–18. Doi: 10.1016/j.edurev.2015.10.003

Fabregat Gesa, R., Gómez Ardila, S. E., Zervas, P., & Sampson, D. G. (2014). Context-aware adaptive and personalized mobile learning delivery supported by UoLmP. *Journal of King Saud University*, 26(1), 47–61. Doi: 10. 1016j.ksuci.2013.10.008

Falcão, T. P., Peres, de Morais, F. M. D. A., D. C. S., & da Silva Oliveira, G. (2017). Participatory methodologies to promote student engagement in the development of educational digital games. *Computers & Education*, 116, 161–175. Doi: 10.1016/jcompedu.2017-09.006

Federal Republic of Nigeria (2013). National policy on education: Roadmap for Nigerian

educational sector. Published by NERDC, Yaba, Lagos.
Groff, J. S. (2017). Personalized learning: The state of the field & future directions. Center for Curriculum Redesign, 47(1), 1–44.
Halverson, R. (2019). Taking a learning sciences perspective to understand personalized learning in schools. In Presentation at the 2019 Annual Meeting of the American Educational Research Association, Toronto, Canada.
Hunsu, N. J., Adesope, O., & Bayly, D. J. (2016). A meta-analysis of the effects of audience response systems (clicker-based technologies) on cognition and affect. Computers & Education, 94(1), 102–119. Doi: 10.1016/j.compedu.2015.11.013
Hyde, J. S. (2016). Sex and cognition: Gender and cognitive functions. Current Opinion in Neurobiology, 38(1), 53-56. Doi: 10.1016/j.conb.2016.02.007
James, O. C., Uchenna, O. T., & Anthony, A. (2025). Effect of personalized learning strategy on senior secondary school students' achievement in mathematics. Education Journal, 14(5), 240–256. DOI: 10.11648/j.edu.20251405.14
Kollosche, D., Steflitsch, D. & Daweis-weidlinger, K. M. (2024). Gender, mathematics and mathematics education. In book: Breaking images, 2024, pp 575-594. Doi: 10.11647/obp.0407.19
Major, L., Francis, G. A., & Tsapali, M. (2021). The effectiveness of technology-supported personalised learning in low-and middle-income countries: A meta-analysis. British Journal of Educational Technology, 52(5), 1935–1964. Doi: 10.1111/bjet.13116
McLeskey, J. L., Rosenberg, M. S., & Westling, D. L. (2017). Inclusion: Effective practices for all students. Pearson
Nandigam, D., Tirumala, S. S. & Baghaei, N. (2014). Personalized learning: Current status and potential. In: 2014 IEEE conference on e-learning, e-management and e-services (IC3e). IEEE; 2014. pp. 111–6. Doi: 10.1109/ic3e.2014.7081251
Nitkin, D., Ready, D. D., & Bowers, A. J. (2022). Using technology to personalize middle school math instruction: Evidence from a blended learning program in five public schools. Frontiers in Education, 7(1), 1-23. DOI: 10.3389/feduc.2022.646471
Pantziara, M., & Philippou, G. (2012). Levels of students' conception of fractions. Educational Studies in Mathematics, 79, 61–83. Doi: 10.1007/s10649-011-9338-x
Patall, E. A., Cooper, H., & Wynn, S. R. (2010). The effectiveness and relative importance of choice in the classroom. Journal of Educational Psychology, 102, 896–915. doi:10.1037/a0019545
Prince, M., & Felder, R. (2016). Inductive teaching and learning methods: Definitions, comparisons, and research bases. Journal of Engineering Education, 95(2), 123-138. Doi: 10.1002/j.2168-9830.2006.tb00884.x
Romiro, G. B. (2021). The effects of personalized instruction on the academic achievement of pupils in Physics. International Journal of Art and Sciences. AMA International University – Bahrain, Kingdom of Bahrain. pp, 1-9
Setambah, M. A. B., Appalanaidu, S. R., Zaini, S. H., et al. (2025). Differentiated instruction: A systematic literature review on implementation guidelines in mathematics education. International Journal of Advanced and Applied Sciences,12(3), 101-108. DOI: 10.21833/ijaas.2025.03.011
Setambah, M. A. B., Saad, M. I. M., Ghazali, N. H. C. M., & Adnan, M. (2024). A comprehensive

synthesis of differentiated instruction approaches in mathematics. LUMAT International Journal on Math Science and Technology Education, 12(4), 3-12. DOI: 10.31129/LUMAT.12.4.2371

Shemshack, A. & Spector, J. M. (2021). A systematic literature review of personalized learning terms. Smart Learning Environment, 7(1):1–20. https://.doi/org/10.1186/s40561-020-00140-9

Shemshack, A., Kinshuk & Spector, J. M. (2021). A comprehensive analysis of personalized learning components. Journal of Computer in Education, 8(4):485–503.

Simpson, J. C. (2020). Successes and challenges of technology-enhanced personalized learning. EDU LEARN20 Proceedings, 8505–8509. Doi: 10.2115/edulearn.2020.2091

Tadlaoui, M. A. & Khaldi, M. (2020). Concepts and interactions of personalization, collaboration, and adaptation in digital learning. In book: Personalization and collaboration in adaptive E-learning. IGI Global Scientific Publishing; 2020. pp. 1–33. Doi: 10.4018/978-1-7998-1492-4.ch001

Vygotsky, L. S. (1978). Mind the society: The development of higher psychological process. Harvard University Press. https://doi.org/10.2307/j.ctvjf9vz4

Walkington, C., & Bernacki, M. L. (2020). Appraising research on personalized learning: Definitions, theoretical alignment, advancements, and future directions. Journal of Research on Technology in Education, 52(3), 235–252. Doi: 10.1080/15391523.2020.1747757

Zhang, L., Carter, R. A., Basham, J. D., & Yang, S. (2022). Integrating instructional designs of personalized learning through the lens of universal design for learning. Journal of Computer Assisted Learning, 38(6), 1639-1656. DOI: 10.1111/jcal.12725