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LEARNING STYLES AND SELF-EFFICACY AS CORRELATES OF ACADEMIC ACHIEVEMENT OF STUDENTS IN MATHEMATICS IN OGIDI EDUCATION ZONE

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Abstract

This study examined the relationship among learning styles, self-efficacy, and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State, Nigeria. The study was guided by five research questions and five null hypotheses tested at the 0.05 level of significance. A correlational research design was adopted. The population comprised 3,718 Senior Secondary Two (SS2) students drawn from 40 public secondary schools in the Ogidi Education Zone. A sample of 560 students was selected using a multi-stage sampling technique. Data were collected using the Learning Styles Questionnaire (LSQ) and the General Self-Efficacy Scale (GSE). Data analysis was conducted using Pearson Product Moment Correlation Coefficient (PPMCC) and multiple regression analysis. The findings revealed that visual learning style had a moderate positive and significant relationship with mathematics achievement ($r = 0.300$, $p < 0.05$), while auditory learning style showed a very low but significant positive relationship ($r = 0.083$, $p < 0.05$). Kinesthetic learning style also demonstrated a low positive and significant relationship with mathematics achievement ($r = 0.180$, $p < 0.05$). However, self-efficacy showed a very low and non-significant relationship with mathematics achievement ($r = 0.052$, $p > 0.05$). The study further revealed a significant joint relationship among learning styles, self-efficacy, and mathematics achievement ($R = 0.316$, $R^2 = 0.100$, $p < 0.05$). The study concluded that learning styles significantly influence students' mathematics achievement, while self-efficacy contributes jointly with learning styles to academic performance. The study therefore recommends that mathematics teachers adopt learner-centred instructional approaches that accommodate diverse learning styles and promote active student engagement in mathematics learning.

Keywords: learning styles, self-efficacy, mathematics achievement, secondary school students, VARK model, academic achievement.

Introduction

Education remains a fundamental instrument for national development and individual advancement because it contributes significantly to the economic, technological, social, and political progress of society. In the contemporary knowledge-driven world, students' academic achievement is widely regarded as an important indicator of educational success and future career prospects. Among school subjects, mathematics occupies a central position because it provides the foundation for scientific innovation, technological development, and logical reasoning. Proficiency in mathematics is therefore essential not only for academic success but also for the development of problem-solving and critical-thinking skills required in modern societies. In Nigeria, mathematics is compulsory at both the primary and secondary school levels and serves as a prerequisite for admission into many tertiary programmes. Despite its importance, students' academic achievement in mathematics continues to fluctuate across different parts of the country, including the Ogidi Education Zone of Anambra State (Taiwo, 2020).

Academic achievement refers to the extent to which learners attain predetermined educational objectives, usually measured through grades, test scores, and standardised assessments. According to Okonkwo, Egolum, and Samuel (2023), academic achievement reflects the level of mastery students demonstrate in a particular subject after a period of learning. Similarly, Duru (2021) described academic achievement as the measurable outcome that indicates the degree of understanding and skills learners have acquired in a given area of study. In the context of mathematics education, academic achievement specifically refers to students' mastery of mathematical concepts, reasoning abilities, and problem-solving skills as reflected in examination results and classroom assessments.

Academic achievement may be categorised as either good or poor depending on the extent to which students attain the desired learning outcomes. Students with high academic achievement usually demonstrate strong conceptual understanding, effective problem-solving abilities, and positive learning behaviours. Studies have shown that such students often possess high self-efficacy, appropriate learning strategies, and learning environments that support their preferred learning styles (Okonkwo et al., 2023; Ozuome, Oguzie, Onwukwe, & Emeji, 2024). Yang, Maeda, and Gentry (2024) further observed that academically successful students are more likely to remain motivated, set realistic academic goals, and sustain consistent effort in learning activities. Conversely, poor academic achievement is characterised by weak conceptual understanding, low examination scores, and difficulties in applying acquired knowledge. Previous studies have linked poor academic achievement to low self-efficacy, emotional challenges, ineffective learning strategies, and instructional approaches that do not align with students' learning preferences (Aliero & Kabiru, 2025; Duru, 2021). Pitsia, Biggart, and Karakolidis (2017) and Zhang and Wang (2020) further argued that poor academic performance often leads to anxiety and low motivation, thereby creating a cycle of repeated academic failure.

The persistent poor performance of students in mathematics has become a major concern for educators, parents, school administrators, and policymakers in Nigeria. Reports from examination bodies such as the West African Examinations Council (WAEC) continue to reveal that a considerable proportion of secondary school students fail to obtain credit-level passes in mathematics, thereby highlighting the seriousness of the problem (Ozuome et al.,

2024). This recurring trend has generated increasing scholarly interest in the factors responsible for students' poor performance in mathematics. While earlier studies focused mainly on external factors such as teacher quality, school facilities, instructional materials, and socio-economic background, recent attention has shifted towards psychological and cognitive variables that may influence students' learning outcomes. In this regard, learning styles and self-efficacy have emerged as important determinants of mathematics achievement in both Nigerian and international contexts (Aliero & Kabiru, 2025; Zhang & Wang, 2020).

Learning styles refer to the preferred ways through which individuals perceive, process, and retain information. Duru (2021) explained that learning styles are shaped by cognitive, affective, and physiological characteristics that influence how learners interact with educational experiences. Similarly, Aliero and Kabiru (2025) defined learning styles as distinctive patterns through which students organise and respond to learning situations. Such preferences are considered important because they influence students' academic engagement, motivation, and achievement (Anyamene & Odalonu, 2022). In this study, learning styles refer specifically to the preferred modes through which secondary school students process and understand mathematics content, whether through visual, auditory, reading/writing, or kinesthetic approaches.

One of the most widely recognised frameworks for understanding learning preferences is the VARK model proposed by Fleming and Mills (1992), which classifies learners into visual, auditory, reading/writing, and kinesthetic categories. Visual learners prefer diagrams, charts, and graphical representations, whereas auditory learners learn more effectively through listening and discussion. Reading/writing learners favour text-based learning materials such as textbooks and written notes, while kinesthetic learners prefer practical and hands-on experiences (Kolawole & Aluko, 2025; Anyamene & Odalonu, 2022). These learning preferences are particularly important in mathematics because the subject often involves abstract reasoning, symbolic representation, and logical deduction. According to Okonkwo et al. (2023), visual learners may understand mathematical concepts more effectively through diagrams and graphical illustrations, while kinesthetic learners may benefit from practical demonstrations and manipulative activities.

Despite the recognised importance of learning styles, instructional practices in many Nigerian secondary schools remain predominantly teacher-centred. Teaching is often based on lectures, rote memorisation, and verbal explanations, with little consideration for students' diverse learning preferences (Anyamene & Odalonu, 2022; Njoku & Abdulhamid, 2016). Such instructional approaches may disadvantage students whose learning styles are not adequately accommodated in the classroom. This challenge is particularly evident in mathematics, where conceptual understanding and problem-solving require more than memorisation. Duru (2021) and Adeniji (2015) argued that mathematics learning requires sequential reasoning and the application of foundational knowledge to increasingly complex tasks. Consequently, students who are not effectively engaged through suitable instructional methods may experience difficulties in understanding mathematical concepts, thereby resulting in poor academic achievement.

In addition to learning styles, self-efficacy has been identified as a significant psychological factor influencing students' academic achievement. Bandura (1997) conceptualised self-efficacy as an individual's belief in his or her ability to organise and

execute actions necessary to achieve desired outcomes. Within educational settings, self-efficacy reflects students' confidence in their ability to successfully complete academic tasks (Schunk & DiBenedetto, 2021). Mathematics self-efficacy specifically relates to students' beliefs about their capacity to understand, solve, and apply mathematical concepts in different learning situations. Students with high self-efficacy are more likely to demonstrate persistence, resilience, and effective problem-solving strategies when faced with academic challenges (Yang et al., 2024; Hickman & Sherman, 2019). By contrast, Zhang and Wang (2020) observed that students with low self-efficacy often display avoidance behaviours, anxiety, and reduced academic motivation, all of which negatively influence academic performance.

Empirical studies have consistently demonstrated the significant relationship between self-efficacy and students' academic achievement. For instance, Ozuome et al. (2024) reported that students with stronger self-efficacy beliefs achieved significantly better results in mathematics than their peers with low self-confidence. Similarly, Okonkwo et al. (2023) found that self-efficacy and learning styles jointly predicted students' academic performance in science-related subjects. Bohrnstedt, Zhang, Park, Ikoma, Broer, and Ogut (2020) further suggested that self-efficacy may mediate the influence of other variables such as motivation and learning environment on students' mathematics achievement.

Importantly, learning styles and self-efficacy may interact in shaping students' academic outcomes. According to Anyamene and Odalonu (2022), when students' preferred learning styles are not accommodated within classroom instruction, repeated learning difficulties may lower their self-efficacy and reduce academic motivation. Conversely, instructional approaches that align with students' learning preferences may strengthen both confidence and academic performance (Kolawole & Aluko, 2025). International studies also support this argument. Ozcan and Kultur (2021) found that mastery experiences and social persuasion significantly influenced students' mathematics self-efficacy and achievement, while Yang and Maeda (2023) noted that poor instructional alignment could widen disparities in students' academic performance. Larsen and Jang (2022) further argued that learner-centred instructional approaches can improve students' confidence, engagement, and persistence in mathematics learning.

Although several studies have independently examined the influence of learning styles and self-efficacy on academic achievement, limited research has investigated their combined relationship with mathematics achievement among secondary school students in Nigeria. Most existing studies focus on general academic performance, tertiary-level students, or contexts outside the Nigerian secondary school system. Furthermore, few studies have specifically examined these variables within the Ogidi Education Zone of Anambra State, despite the persistent concerns regarding students' mathematics achievement in the area. This represents a significant gap in the literature.

Ideally, students should possess the confidence, motivation, and learning opportunities necessary to achieve success in mathematics. However, observations indicate that many teachers continue to employ predominantly lecture-based instructional methods without considering the diverse learning preferences of students. Consequently, many learners experience difficulties in understanding mathematical concepts and develop low confidence in their academic abilities. Therefore, there is a need for empirical research that examines how learning styles and self-efficacy relate to students' mathematics achievement within the

Nigerian secondary school context.Therefore, this study seeks to investigate the relationship between learning styles, self-efficacy, and mathematics academic achievement among secondary school students in the Ogidi Education Zone of Anambra State. The findings of the study are expected to provide evidence that may guide teachers, counsellors, curriculum planners, and educational policymakers in designing learner-centred instructional strategies capable of improving students' mathematics achievement.

Purpose of the Study

The main purpose of this study was to investigate the relationship between learning styles, self-efficacy, and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State, Nigeria. Specifically, the study sought to:

1. examine the relationship between visual learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State;
2. determine the relationship between auditory learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State;
3. investigate the relationship between kinesthetic learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State;
4. ascertain the relationship between self-efficacy and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State; and
5. determine the joint relationship among learning styles, self-efficacy, and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State.

Research Questions

The following research questions guided the study:

1. What is the relationship between visual learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State?
2. What is the relationship between auditory learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State?
3. What is the relationship between kinesthetic learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State?
4. What is the relationship between self-efficacy and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State?

5. What is the joint relationship among learning styles, self-efficacy, and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State?

Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

1. There is no significant relationship between visual learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State.
2. There is no significant relationship between auditory learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State.
3. There is no significant relationship between kinesthetic learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State.
4. There is no significant relationship between self-efficacy and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State.
5. There is no significant joint relationship among learning styles, self-efficacy, and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State.

Theoretical Framework

This study is anchored on Neil Fleming's VARK Learning Styles Model and Albert Bandura's Self-Efficacy Theory. The two theories provide a framework for explaining how students' learning preferences and beliefs about their abilities influence academic achievement in mathematics. While the VARK model explains differences in the ways students process and retain information, Self-Efficacy Theory explains how students' confidence in their capabilities shapes motivation, persistence, and academic performance.

Fleming's VARK Learning Styles Model

The VARK Learning Styles Model was developed by Neil Fleming in 1987 to explain individual differences in learning preferences. The model categorises learners into four modalities: Visual, Auditory, Reading/Writing, and Kinesthetic. Fleming argued that learners understand and retain information more effectively when instruction aligns with their preferred learning styles. Visual learners prefer diagrams, charts, and graphical representations; auditory learners learn best through listening and discussion; reading/writing learners favour text-based materials such as notes and textbooks; while kinesthetic learners prefer practical and hands-on experiences. The model also recognises that some learners may be multimodal, combining more than one learning preference.

The VARK model is relevant to mathematics education because students process mathematical concepts differently. For example, visual learners may better understand mathematical relationships through diagrams and graphs, whereas kinesthetic learners may benefit from practical demonstrations and manipulative activities. The model therefore suggests that instructional strategies aligned with students' learning preferences may improve engagement, understanding, and academic achievement. In this study, the VARK framework

provides a basis for examining how learning styles relate to students' academic achievement in mathematics. However, the model does not adequately explain the role of students' confidence and motivation in learning outcomes. Consequently, Bandura's Self-Efficacy Theory complements the framework of the study.

Albert Bandura's Self-Efficacy Theory

Albert Bandura's Self-Efficacy Theory, first proposed in 1977 and later expanded in 1997, explains how individuals' beliefs about their capabilities influence behaviour, motivation, and performance. According to Bandura (1977), self-efficacy refers to an individual's belief in his or her ability to organise and execute actions necessary to achieve specific goals. The theory posits that individuals with high self-efficacy are more likely to embrace challenges, persist in difficult tasks, and recover from setbacks, whereas those with low self-efficacy often avoid challenging activities and experience anxiety or low motivation. Bandura identified four major sources of self-efficacy: mastery experiences, vicarious experiences, verbal persuasion, and physiological or emotional states. In mathematics education, self-efficacy influences students' confidence in solving problems, their persistence during difficult tasks, and their overall academic achievement. Students who believe in their mathematical abilities are more likely to participate actively, practise consistently, and achieve better academic outcomes.

The theory is relevant to this study because it explains how students' beliefs about their capabilities may influence mathematics achievement. When combined with the VARK model, Self-Efficacy Theory provides a comprehensive explanation of how learning preferences and confidence interact to shape students' academic performance. For instance, instructional strategies that aligns with students' learning styles may enhance mastery experiences and strengthen self-efficacy, thereby improving achievement in mathematics. Therefore, the integration of the VARK Learning Styles Model and Self-Efficacy Theory provides an appropriate framework for understanding the relationship among learning styles, self-efficacy, and academic achievement in mathematics among secondary school students.

Methods

Research Design

This study adopted a correlational research design to examine the relationship among learning styles, self-efficacy, and academic achievement in mathematics among secondary school students. According to Nworgu (2015), correlational research is appropriate for determining the direction and magnitude of relationships among variables without manipulating them.

Population and Area of Study

The study was conducted in the Ogidi Education Zone of Anambra State, Nigeria, which comprises Idemili North and Idemili South Local Government Areas. The population consisted of 3,718 Senior Secondary Two (SS2) students drawn from 40 public secondary schools in the zone (Anambra State Post Primary Schools Service Commission [PPSSC], 2024).

Sample and Sampling Technique

A sample of 560 SS2 students, representing approximately 15% of the population, was selected using a multi-stage sampling procedure. First, simple random sampling was used to

select six schools from each local government area. Thereafter, proportional sampling was employed to determine the number of participants selected from each school, while simple random sampling was used to select the final respondents.

Instrument for Data Collection

Data were collected using two standardised instruments: the Learning Styles Questionnaire (LSQ) developed by O'Brien (1985) and the General Self-Efficacy Scale (GSE). The LSQ contained 30 items divided into visual, auditory, and kinesthetic dimensions, rated on a three-point scale ranging from "Never" to "Often." The GSE comprised 10 items measured on a four-point Likert scale ranging from "Not at all true" to "Exactly true." Higher scores on the scales indicated stronger learning style preferences and higher self-efficacy beliefs respectively. The instruments were validated by two experts in Guidance and Counselling and one expert in Measurement and Evaluation from the Faculty of Education, Nnamdi Azikiwe University, Awka. Reliability indices from previous studies showed acceptable internal consistency coefficients for the LSQ ($\alpha = 0.82$ and $\alpha = 0.86$) and the GSE ($\alpha = 0.88$), indicating that the instruments were reliable for the study.

Method of Data Collection

Formal approval for data collection was obtained from the Post Primary Schools Service Commission (PPSSC), after which the researcher visited the selected schools to administer the instruments with the assistance of trained research assistants. The questionnaires were administered in supervised classroom settings and retrieved immediately after completion. Data collection lasted for two weeks.

Method of Data Analysis

Data were analysed using inferential statistics. Pearson Product Moment Correlation Coefficient (PPMCC) was used to answer research questions one to four, while multiple regression analysis was used to determine the joint relationship among learning styles, self-efficacy, and academic achievement in mathematics. The hypotheses were tested at the 0.05 level of significance using SPSS.

Results

Research Question 1

What is the relationship between the visual learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone?

Null Hypothesis 1

There will be no significant relationship between the visual learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone.

Table 1: Pearson r on the relationship between the visual learning style and academic achievement in mathematics among public secondary school students

Source of Variation	N	Visual Learning Style r	Acad. Achievement in Maths r	Cal t	Pvalue	Remark

Visual Learning Style	543	1	.300	6.269	.000	Sig. moderate positive relationship
Acad. Achievement in Maths	543	.300	1			

The results in Table 4.3.4 revealed a moderate positive relationship between visual learning style and mathematics achievement (r = 0.300) among public secondary school students in the Ogidi Education Zone.

Also, the calculated t-value (t = 6.269), with a p-value of .000 indicates that the relationship is statistically significant at the stipulated 0.05 level. Based on this finding, the null hypothesis which stated that there is no significant relationship between visual learning style and academic achievement in mathematics is rejected.

Research Question 2

What is the relationship between the auditory learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone?

Null Hypothesis 2

There is no significant relationship between the auditory learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone.

Table 2 : Pearson r on the relationship between the auditory learning style and academic achievement in mathematics among public secondary school students

Source of Variation	N	Auditory Learning Style r	Acad. Achievement in Maths r	Cal t	Pvalue	Remark
Visual Learning Style	543	1	.083	-.241	.026	Sig. V. low positive relationship
Acad. Achievement in Maths	543	.083	1			

The results in Table 4.5.1 showed that the Pearson correlation coefficient indicated a very low positive relationship between auditory learning style and mathematics achievement (r = 0.083) among public secondary school students in the Ogidi Education Zone.

Also, the calculated t-value (t = −0.241) with a p-value of .026 shows that the relationship is statistically significant at the 0.05 level. Based on this finding, the null hypothesis which stated that there is no significant relationship between auditory learning style and academic achievement in mathematics is rejected.

Research Question 3

What is the relationship between the kinesthetic learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone?

Null Hypothesis 3

There is no significant relationship between the kinesthetic learning style and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone.

Table3: Pearson r on the relationship between the kinesthetic learning style and academic achievement in mathematics among public secondary school students

Source of Variation	N	Kinesthetic Learning Style r	Acad. Achievement in Maths r	Cal t	Pvalue	Remark
Kinesthetic Learning Style	543	1	.180	2.176	.000	Sig. low positive relationship
Acad. Achievement in Maths	543	.180	1			

The results in Table 4.7.1 revealed a low positive relationship between kinesthetic learning style and mathematics achievement (r = 0.180) among public secondary school students in the Ogidi Education Zone.

Also, the calculated t-value (t = 2.176) with a p-value of .000 indicates that the relationship is statistically significant at the 0.05 level. Based on this finding, the null hypothesis which stated that there is no significant relationship between kinesthetic learning style and academic achievement in mathematics is rejected.

Research Question 4

What is the relationship between self-efficacy and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone?

Null Hypothesis 4

There is no significant relationship between self-efficacy and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone.

Table 4: Pearson r on the relationship between self-efficacy and academic achievement in mathematics among public secondary school students

Source of Variation	N	Kinesthetic Learning Style r	Acad. Achievement in Maths r	Cal t	Pvalue	Remark
	543	1	.052	.836	.114	

Kinesthetic Learning Style				Non-sig. very low positive relationship
Acad. Achievement in Maths	543	. 052	1	

The results in Table 4.8.1 revealed a very low positive relationship between self-efficacy and mathematics achievement (r = 0.052) among public secondary school students in the Ogidi Education Zone.

Also, the calculated t-value (t = 0.836) with a p-value of .114 shows that the relationship is not statistically significant at the 0.05 level. Therefore, the null hypothesis which stated that there is no significant relationship between self-efficacy and academic achievement in mathematics is accepted.

Research Question 5

What is the joint correlation of learning styles and self-efficacy on academic achievement in mathematics among public secondary school students in the Ogidi Education Zone?

Null Hypothesis 5

There is no significant relationship between Learning styles and self-efficacy on academic achievement in mathematics among public secondary school students in the Ogidi Education Zone.

Table 5: Regression analysis on the joint correlation of learning styles and self-efficacy on academic achievement in mathematics among public secondary school students

R	R Square	Adjusted R Square	%	df	Cal. F	Pvalue	Remark
.316	.100	.093	10.0%	538	14.962	.000	Significant

The results in Table 4.10.1 showed the joint relationship of learning styles and self-efficacy with academic achievement in mathematics among public secondary school students in the Ogidi Education Zone. The multiple correlation coefficient (R = 0.316) indicates a moderate positive joint relationship between the predictor variables and mathematics achievement. The coefficient of determination ($R^2 = 0.100$) shows that learning styles and self-efficacy jointly explain 10.0% of the variance in students' academic achievement in mathematics.

Also, the calculated F-value (F = 14.962) with a p-value of .000 indicates that the joint relationship is statistically significant at the 0.05 level. Based on this finding, the null hypothesis which stated that there is no significant relationship between learning styles, self-efficacy, and academic achievement in mathematics is rejected.

Discussion

The findings of this study revealed that visual learning style had a moderate positive and statistically significant relationship with academic achievement in mathematics among public secondary school students in the Ogidi Education Zone. This suggests that students who prefer visual methods of learning, such as diagrams, charts, graphs, and symbolic representations, are more likely to perform better in mathematics. One possible reason for this finding is that mathematics involves abstract concepts, logical structures, and symbolic representations which are more easily understood when presented visually. Visual aids may therefore enhance students' comprehension, retention, and problem-solving abilities.

This finding agrees with the VARK Learning Styles Model proposed by Fleming (1987), which argues that learners achieve better outcomes when instructional methods align with their preferred learning styles. The finding is also consistent with the studies of Anyamene and Odalonu (2022), Ogbonna (2017), Obi and Ahmed (2023), and Enyinna and Okigbo (2025), all of whom reported that visual learning preference positively influenced students' mathematics achievement. Similarly, Ofori and Owusu-Agyeman (2020) found that visual learners in Ghana performed significantly better in mathematics than students with less dominant visual preferences. The finding also supports the work of Kolawole and Aluko (2025), who observed that students exposed to instructional strategies that matched their learning styles demonstrated improved academic performance and skill development.

However, the finding contrasts with Husmann and O'Loughlin (2019), who argued that there is limited empirical evidence supporting the assumption that matching instructional methods to learning styles directly improves academic achievement. Despite this criticism, the present finding suggests that visual instructional approaches remain beneficial in mathematics learning, particularly within the Nigerian secondary school context where abstract concepts often challenge learners.

The study further revealed a very low but statistically significant positive relationship between auditory learning style and academic achievement in mathematics. Although the relationship was weak, it indicates that students who prefer verbal explanations, discussions, and listening activities may still benefit academically in mathematics. This finding may be explained by the fact that many Nigerian classrooms predominantly adopt lecture-based teaching methods, thereby favouring students with auditory learning preferences. Students who effectively process spoken information may therefore gain a slight academic advantage in classroom learning environments.

This finding is consistent with the studies of Njoku and Abdulhamid (2016) and Anyamene and Odalonu (2022), who found that auditory learners demonstrated positive academic outcomes when exposed to teacher-centred instructional methods. The result also aligns with the findings of Rao and Rao (2020) and Mahmoud and Reem (2022), who reported that auditory learning contributed positively to students' academic performance, although the effect was relatively weak compared to other learning styles. Similarly, Brown, Taylor, and Greenwood (2022) observed that auditory learners benefitted from classroom discussions and verbal instructional strategies. Nevertheless, the weak nature of the relationship suggests that reliance on verbal instruction alone may not be sufficient for effective mathematics learning. This partly disagrees with the findings of Adewale (2020), who reported stronger effects of

auditory learning on students' academic achievement. The difference may be attributed to variations in subject area, classroom practices, and educational contexts.

The findings also showed that kinesthetic learning style had a low positive and statistically significant relationship with mathematics achievement. This implies that students who prefer practical, activity-based, and hands-on learning experiences tend to achieve better results in mathematics. A likely explanation for this finding is that kinesthetic activities enable students to engage actively with mathematical concepts, thereby improving conceptual understanding and retention. Practical demonstrations and manipulative activities may also reduce the abstract nature of mathematics and make learning more meaningful.

This finding supports the experiential learning perspective of Kolb (1984), which emphasises the importance of active engagement and practical experience in effective learning. The finding also agrees with Chieke, Madu, Ewelum, and Adebola (2019), who found that kinesthetic learning positively predicted academic performance among adult learners in Anambra State. Similarly, Adeniji (2015), Aliero and Kabiru (2025), and Enyinna and Okigbo (2025) reported that kinesthetic learning approaches improved students' academic performance in mathematics and science-related subjects. Furthermore, Martinez and Lee (2022) found that students exposed to activity-based learning demonstrated higher satisfaction and better academic outcomes. However, the relatively low strength of the relationship may indicate that practical learning opportunities are still limited within many Nigerian secondary schools. This may be due to inadequate instructional resources, overcrowded classrooms, and continued dependence on traditional teaching methods, as noted by Yusuf and Balogun (2021) and Okafor and Enemuo (2024).

Contrary to expectations, the study revealed a very low positive but non-significant relationship between self-efficacy and academic achievement in mathematics. This finding suggests that students' beliefs about their capabilities did not significantly predict mathematics achievement within the study area. One possible explanation is that external factors such as poor instructional quality, inadequate learning facilities, examination anxiety, and socio-economic challenges may have weakened the influence of self-efficacy on academic performance. It is also possible that students possessed confidence in their abilities but lacked the necessary academic support and learning resources to translate such confidence into improved achievement.

This finding disagrees with Bandura's (1977, 1997) Self-Efficacy Theory, which posits that individuals with stronger efficacy beliefs are more likely to demonstrate persistence, resilience, and academic success. The finding also contrasts with numerous empirical studies which established significant positive relationships between self-efficacy and mathematics achievement. For example, Ozuome et al. (2024), Okoro (2021), Yang, Maeda, and Gentry (2024), and Yousuf and Rajeswari (2024) all reported that self-efficacy significantly predicted students' mathematics performance. Similarly, Zhang and Wang (2020), Keşan and Kaya (2018), and Ugwuanyi, Okeke, and Asomugha (2020) found that students with high self-efficacy demonstrated greater motivation and better academic achievement.

The present finding also disagrees with the studies of Rahman and Islam (2019), Nguyen and Tran (2023), and Asare (2025), which revealed strong positive effects of self-efficacy on academic achievement across different educational settings. However, the finding is partly consistent with Sakellariou (2022), who argued that the relationship between self-

efficacy and mathematics achievement may vary depending on contextual and environmental factors. The weak relationship observed in the present study may therefore suggest that self-efficacy alone is insufficient to guarantee academic success without supportive instructional and environmental conditions.

Finally, the study found a significant joint relationship among learning styles, self-efficacy, and academic achievement in mathematics. The predictor variables jointly explained 10.0% of the variance in students' mathematics achievement. This finding indicates that learning styles and self-efficacy collectively contribute to students' academic outcomes, even though self-efficacy independently showed a non-significant relationship.

The finding supports the interactionist perspective of Bandura's Social Cognitive Theory (1986), which emphasises the reciprocal interaction among personal factors, behaviour, and environmental influences in shaping academic outcomes. The result also aligns with the studies of Abah and Okeke (2023), Adebayo and Ojo (2019), Adetunji and Olufunke (2015), and Okeke and Nwafor (2021), all of whom found that learning styles and self-efficacy jointly predicted students' mathematics achievement. Similarly, Kim and Lee (2022), Mthembu and Mthembu (2022), and Yildirim and Yildirim (2022) reported that students' academic achievement was influenced by the combined effects of cognitive preferences and motivational beliefs. The finding further agrees with Juniati and Budayasa (2022), who argued that both cognitive and affective factors jointly determine students' mathematics performance. In the same vein, Larsen and Jang (2022) reported that instructional practices that support students' confidence and learning preferences significantly improve mathematics achievement. Therefore, the present study reinforces the view that effective mathematics learning is multidimensional and influenced by the interaction of learning preferences, motivational beliefs, and instructional support.

Conclusion

This study examined the relationship among learning styles, self-efficacy, and academic achievement in mathematics among public secondary school students in the Ogidi Education Zone of Anambra State, Nigeria. The findings revealed that visual, auditory, and kinesthetic learning styles were positively related to students' mathematics achievement, although the strength of the relationships varied. Visual learning style demonstrated the strongest relationship with mathematics achievement, suggesting the importance of visual instructional approaches in mathematics teaching. The study further revealed that self-efficacy had a positive but non-significant relationship with mathematics achievement. However, learning styles and self-efficacy jointly showed a significant relationship with academic achievement, indicating that students' learning preferences and motivational beliefs collectively contribute to mathematics performance.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Mathematics teachers should adopt learner-centred instructional approaches that integrate visual materials such as diagrams, charts, graphs, and illustrations, since visual learning style showed the strongest relationship with mathematics achievement.

2. Teachers should combine verbal explanations with interactive classroom discussions and collaborative learning activities to support students with auditory learning preferences and improve conceptual understanding in mathematics.
3. Schools should encourage the use of practical and activity-based instructional strategies, including demonstrations, manipulatives, and problem-solving exercises, to enhance learning among kinesthetic learners.
4. Guidance counsellors and teachers should help students identify and understand their dominant learning styles so that they can adopt more effective and personalised learning strategies.
5. Educational stakeholders, including school administrators and curriculum planners, should organise regular training and professional development programmes for mathematics teachers on differentiated instruction and learning-style-responsive teaching methods.
6. Although self-efficacy showed a non-significant relationship with mathematics achievement, teachers and parents should continue to provide encouragement, constructive feedback, and supportive learning environments that can strengthen students' confidence and motivation towards mathematics learning.

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