FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 9 No. 8, August, 2025, pp 296 – 302
DOI: https://doi.org/10.33003/fjs-2025-0908-3920

INVESTIGATING THE PREFERRED LEARNING STYLES OF POLYTECHNIC STUDENTS IN MATHEMATICS IN NIGERIA: IMPLICATIONS FOR MATHEMATICS INSTRUCTION

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ABSTRACT
This study investigates the preferred learning styles of polytechnic students in Nigeria and their impact on academic performance in mathematics. Using a quantitative survey design, 500 National Diploma One (ND 1) students from Plateau State Polytechnic, Barkin Ladi, and Isa Mustapha Agwai Polytechnic, Lafia were sampled. Data were collected through the Perceptual Learning Style Preference Questionnaire (PLSPQ) and students' academic records. Descriptive statistics and Pearson correlation and analysis of variance (ANOVA) were used for data analysis. The study found that auditory and visual learning styles were most preferred and had a statistically significant relationship with students' mathematics performance. Gender differences were also found to significantly influence performance, whereas institutional affiliation had no significant effect. Based on these findings, the study recommends the integration of multimodal teaching methods to enhance mathematics instruction and support diverse learning needs in polytechnics.

Keywords: Learning styles, Mathematics, Nigeria, Academic Performance, Teaching Strategies

INTRODUCTION
Mathematics is a critical subject in polytechnic education and plays an essential role in shaping the academic and professional trajectory of students in science and engineering disciplines. Despite its importance, mathematics remains one of the most challenging subjects for many students. In the Nigerian polytechnic context, students often develop negative attitudes towards mathematics, particularly due to its abstract nature and reliance on formulas and rules. This is especially true for students from social science or non-mathematical backgrounds, who may find it difficult to relate to mathematical content (Prayoga & Abraham, 2017; Altintas & Ilgün, 2017). Such challenges have resulted in high failure rates, course withdrawals, poor academic outcomes, and, in some cases, complete disengagement from school. Academic records from Plateau State Polytechnic, Barkin Ladi, throughout five academic sessions (2019/2020 to 2023/2024) reveal persistent underperformance in mathematics, with recurring issues such as examination malpractice, absenteeism, and inadequate preparation. Even when students manage to graduate, many are not adequately equipped with the mathematical competence necessary for their professional careers.

One of the primary causes of poor mathematics performance is the mismatch between students' preferred learning styles and the teaching methods adopted by instructors. Gloria (2015) suggests that students have low performance in mathematics due to a lack of concept, mathematical skills, or understanding of the fundamental manipulation and loving mathematics. Consequently creating negativity toward the subject.

To improve learning in higher education, the primary focus should be on engaging students in a process that best enhances their learning —a process that includes feedback on the effectiveness of their learning efforts. (Kolb, 2005). Students differ in how they learn best, some may prefer auditory methods, others may benefit from visual aids, and some may grasp concepts more effectively through tactile or kinaesthetic experiences. Teachers' understanding of these diverse learning preferences is essential for enhancing student engagement and improving academic outcomes. Which is why Brown (2003) suggests that teaching learners with their preferred learning style can help them develop the adeptness necessary to handle a different range of learning requirements. Research also shows that when instructional strategies align with students' preferred learning styles, learning becomes more effective, enjoyable, and long-lasting (Cardino & Cruz, 2020). Conversely, uniform and rigid teaching methods often lead to disengagement, boredom, and academic underperformance (Tulbure, 2012). Brodsky (2017) emphasized that the learning environment, including how the material is delivered, significantly influences student outcomes.

The rise of Generation Z, who are digital natives, has further complicated the dynamics of teaching and learning. These students are accustomed to multimedia technologies and expect educational content to be delivered through digital formats, including videos, podcasts, and interactive platforms. Abrahams (2015) noted that Generation Z students not only use technology as a learning tool but often rely on it as an essential part of their everyday lives. This generational shift necessitates a reevaluation of traditional teaching approaches in favour of more engaging, technology-integrated strategies that reflect current student expectations and behaviours.

The theoretical foundation for this study is Kolb's Experiential Learning Theory, which posits that learning is a process whereby knowledge is created through the transformation of experience. According to Kolb (1984), effective learning occurs when individuals are able to engage in concrete experiences, reflect on them, conceptualize the outcomes, and then actively experiment. This model underscores the importance of tailoring learning experiences to fit individual preferences and cognitive strengths. Felder (1994) further categorized learning preferences into four key types: visual, auditory, tactile, and kinaesthetic, each of which offers unique insights into how students perceive and process information. The literature suggests that students who are taught using methods aligned with their learning preferences not only perform better but also develop stronger problem-solving skills and greater academic confidence (Stewart &Felicetti, 1992; Nzesei, 2015).

Given the pressing need to improve mathematics performance in polytechnics, this study seeks to explore how learning styles affect student outcomes. Specifically, it aims to identify the most preferred learning styles among National Diploma One students in Plateau State Polytechnic and Isa Mustapha Agwai Polytechnic and to examine the relationship between these preferences and students' academic performance in key mathematics courses. The study also investigates whether gender and school affiliation play a role in influencing mathematics achievement. Ultimately, the goal is to provide actionable insights for educators and policymakers to reform instructional practices, making them more inclusive and effective for a diverse student population. By doing so, this research contributes to the broader discourse on learner-centred education and offers practical recommendations for improving mathematics instruction in Nigeria's polytechnic system.

MATERIALS AND METHODS

A quantitative survey research design was employed for this study to assess students' learning styles and academic performance in mathematics. The study was conducted in Plateau State Polytechnic, Barkin Ladi, and Isa Mustapha Agwai Polytechnic, Lafia, targeting National Diploma One (ND I) students in the Schools of Science and Engineering. The study was made up of a sample population size of 500 students, 250 students were drawn from each institution through stratisfied random sampling. Of this sample size, 113 were females and 387 were males. Regarding school affiliations, 314 students were from the school of science and the remaining 186 students were from the school of engineering.

Perceptual Learning Style Preference Questionnaire (PLSPQ) was the primary instrument for data collection, supplemented with students' academic performance records in MTH 111, MTH 112, and MTH 121 as approved by the Academic Boards (AB) of the respective institutions. Fourty research questions on PLSPQ were developed consisting of ten questions on each of the four learning styles. Gender was also included in the questionnairein order to identify the number of male and females. Statistical Package for the Social Sciences (SPSS) version 28.0 was employed for the analysis of the data at significant level of five percent or 0.05. Data were analysed using descriptive statistics to categorise learning style preferences, while Pearson correlation and Analysis of Variance (ANOVA) were used to test for relationships and differences among variables to quantify strength and direction of their association, that is, whether higher scores on one variable tend to be consistently associated with higher or lower scores on another. This was also to determine if observed variations in learning preferences across different categories of students were statistically significant. The Likert scale employed ranged from 1 (Strongly Disagree) to 5 (Strongly Agree), aligning students' responses with specific learning preferences.

RESULTS AND DISCUSSION

Table 1: Kinaesthetic Learning Style (in Percentages)

S/N	Item	µ	ð	Remark
1.	I use kinaesthetic checklists or flowcharts to help with mathematical problem-solving.	3.18	1.25	Disagreed
2.	I prefer to create and use physical models to learn or practice mathematical concepts.	3.52	1.30	Agreed
3.	I prefer to learn mathematics through hands-on experiments or activities.	3.61	1.27	Agreed
4.	I learn mathematical concepts better when I can move around and engage in physical activities.	3.28	1.33	Disagreed
5.	I use kinaesthetic aids, such as movement cards or action diagrams to help with mathematical problem solving.	3.64	1.18	Agreed
6.	I prefer to work on mathematical problems or projects that involve building or constructing.	3.16	1.26	Disagreed
7.	I learn mathematical concepts better when I act them out or use gestures.	3.53	1.19	
8.	I use real-life scenarios or applications to learn and practice mathematical concepts.	3.55	1.31	
9.	I prefer to engage in mathematical games or simulations that involve physical movement.	3.30	1.27	
10.	I learn mathematical concepts better when I can use my body to represent mathematical relationships or concepts.	3.54	1.23	

Table 1 explores kinaesthetic learning preferences, where students learn best by engaging in physical activities. The responses revealed mixed but insightful patterns. High agreement was found in items such as "I prefer to learn mathematics through hands-on experiments or activities" (mean = 3.61) and "I use kinaesthetic aids such as movement cards or action diagrams" (mean = 3.64). However, lower scores were observed in statements like "I use kinaesthetic checklists or flowcharts to help with problem-solving (mean = 3.18) and "I prefer to work on projects that involve building or constructing" (mean = 3.16). These variations suggest that while many students appreciate kinaesthetic engagement, the effectiveness may depend on the nature of the activity. This supports the study's first objective by identifying kinaesthetic preferences and demonstrating their partial effectiveness in learning mathematics.

Table 2: Tactile Learning Style

S/N	Item	µ	ð	Remark
1.	I prefer to use manipulatives, such as counting bottle corks to learn mathematical concepts.	3.64	1.42	Agreed
2.	I learn mathematics better when I can touch and handle physical objects.	3.31	1.31	Disagreed
3.	I prefer to use tactile aids, such as number lines to help with mathematical calculations.	3.63	1.28	Agreed
4.	I prefer to create and use physical flashcards to review mathematical concepts.	3.22	1.28	Disagreed
5.	I prefer to write mathematical problems or equations by hand.	3.78	1.15	Agreed
6.	I learn mathematical concepts better when I can create and manipulate physical models.	3.25	1.28	Disagreed
7.	I use tactile diagrams or charts to help with mathematics problem-solving.	3.56	1.12	Agreed
8.	I use tactile checklists or flow charts to help with mathematical problem-solving.	3.10	1.25	Disagreed
9.	I prefer to work with physical materials, such as play dough or clay to learn mathematical concepts.	3.22	1.32	Disagreed
10.	I learn mathematical concepts better when I can use my hand to explore and discover mathematical relationships.	3.55	1.18	Agreed

Table 2 focuses on tactile learning, involving hands-on manipulation of objects. Students showed a strong preference for writing mathematical problems by hand (mean = 3.78) and using manipulatives like counting corks (mean = 3.64). Statements such as “I learn mathematics better when I can use my hand to explore relationships” (mean = 3.55) also ranked highly. In contrast, preferences were lower for using materials like play dough (mean = 3.22) or tactile checklists (mean = 3.10). These findings indicate that tactile learning is valued by students when it involves traditional tools like pens and charts rather than unconventional manipulatives, reinforcing the need for tailored instructional methods.

Table 3: Auditory Learning Style

S/N	Item	µ	ð	Remark
1.	I prefer to use graphs, charts, or diagrams to solve mathematical problems.	2.84	1.34	Disagreed
2.	I learn mathematical concepts better when they are presented in an audio format, such as lecture audio or recording.	3.64	1.28	
3.	I prefer to use audio recordings to review mathematical concepts or practice mathematical problems	3.53	1.46	Agreed
4.	I prefer to use rhymes, songs, or raps to remember mathematical formulae or concepts.	2.99	1.31	Disagreed
5.	I prefer to work in a quiet environment with minimal distractions to focus on mathematical concepts.	3.60	1.37	Agreed
6.	I learn mathematical concepts better when they are explained orally, such as in a one-on-one tutoring session.	3.52	1.37	Agreed
7.	I prefer to engage in mathematical discussions or debates to deepen my understanding of mathematical concepts.	3.63	1.22	Agreed
8.	I learn mathematical concepts when they are presented in a step-by-step auditory format.	3.54	1.45	Agreed
9.	I use verbal self-talk or oral repetition to help with mathematical problem-solving.	3.24	1.31	Disagreed
10.	I prefer to listen to mathematical explanations or tutorials at a slow deliberate pace	3.59	1.32	Agreed

Table 3 evaluates auditory learning preferences. The strongest agreement appeared for statements such as “I learn better through audio formats like lecture recordings” (mean = 3.64), “I prefer mathematical discussions or debates” (mean = 3.63), and “I learn better when concepts are explained orally” (mean = 3.52). This confirms that auditory learning is highly favoured, aligning with the overall finding that the auditory style had the highest mean score across all learning preferences. It highlights the importance of integrating lecture-based delivery, verbal explanations, and interactive discussions in mathematics classes.

Table 4: Visual Learning Style

S/N	Item	µ	ð	Remark
1.	I prefer to listen to audio explanations to learn mathematical concepts.	3.72	1.27	Agreed
2.	I prefer to use visual shapes and patterns to understand mathematical concepts.	3.32	1.32	Disagreed
3.	I use visual flowcharts to help with mathematical problem-solving	3.51	1.20	Agreed
4.	I prefer to use visual aids like geometric shapes, and numbers lines to help with mathematical calculations.	3.67	1.29	Agreed
5.	I prefer to watch video tutorials to learn new mathematical concepts.	3.61	1.28	Agreed
6.	I prefer to use different colours or highlighting to organise or review mathematics notes.	3.16	1.27	Disagreed
7.	I create mental images or diagrams to solve mathematical word problems.	3.13	1.27	Disagreed
8.	I prefer to use visual models such as blocks or counting bears to present mathematical concepts.	3.56	1.26	Agreed
9.	I prefer to use visual checklists or flowcharts to help with mathematical problem-solving.	3.60	1.23	Agreed
10.	I prefer to create concept maps or mind maps to organise and review mathematical concepts.	3.19	1.33	Disagreed

Table 4 analyses visual learning preferences, another highly rated style. Strong agreement was noted for items like "I prefer visual aids like geometric shapes and number lines" (mean = 3.67) and "I prefer to watch video tutorials" (mean = 3.61). However, items like "I create mental images or diagrams" (mean = 3.13) and "I use colour coding in notes" (mean = 3.16) scored lower, suggesting that visual preference is more effective when students interact with external aids rather than internal visualization. This again validates the study's first objective, affirming visual learning as a dominant preference.

Table 5: Summary Across Learning Styles

Learning Style	Items Agreed	Average Mean	Interpretation
Kinaesthetic	6/10	~3.44	Moderate preference, especially with physical engagement.
Tactile	5/10	~3.45	Mixed responses, stronger in manual engagement (e.g., writing).
Auditory	7/10	~3.53	Strong preference, especially for lectures and oral explanations.
Visual	6/10	~3.50	High preference, especially for diagrams and video-based learning.

Table 5 presents a summary of all four learning styles. Auditory learning recorded the highest average mean of 3.53, followed by visual (3.50), tactile (3.45), and kinaesthetic (3.44). These rankings confirm the dominance of auditory and visual styles, thereby justifying instructional strategies that prioritize these modalities.

Table 6: Analysis of Variance (ANOVA) Statistics of Students' Learning Styles on their Performance

Source of Variation	Sum of Square	Degree of freedom	Mean Square	F-value	P-value
Between groups (learning style)	176.327	3	58.776	49.642	0.000
Within groups (error)	587.432	496	1.184		
Total	763.759	499			

Table 6 addresses the second objective by analyzing the relationship between learning styles and academic performance using ANOVA. The result yielded an F-value of 49.642 and a p-value of 0.000, indicating a statistically significant difference in performance based on learning style. This means that students' preferred learning styles do impact how well they perform in mathematics courses such as Logic and Linear Algebra (MTH 111), Functions and Geometry (MTH 112), and Calculus (MTH 121).

Table 7: T-test Comparison Between Students' Gender and Student Performance in Mathematics

Groups	N	Mean	Standard Deviation	df	t-value	P-value	Remark
Male	387	37.429	2.452	498	27.530	0.000	Significant
Female	113	28.325	3.257				

Table 7 evaluates gender differences in performance through a t-test. Male students had a mean score of 37.429 (SD = 2.452), significantly higher than females who scored 28.325 (SD = 3.257), with a t-value of 27.530 and $p < 0.05$. This statistically significant difference suggests that gender is a contributing factor in students' performance, possibly due to confidence levels, prior exposure, or societal expectations surrounding mathematics.

Table 8: T-test Comparison Between Students' Schools and Student Performance in Mathematics

Groups	N	Mean	Standard Deviation	df	t-value	P-value	Remark
Sciences	304	39.512	14.051	498	0.409	0.473	Significant
Engineering	196	38.861	19.227				

Table 8 examines whether the institution attended affected performance. The mean scores for Science students (39.512) and Engineering students (38.861) were similar, and the t-value (0.409) with a p-value of 0.473 indicates no statistically significant difference. This implies that learning style impact is consistent across both schools, strengthening the general applicability of the study's recommendations.

The descriptive analysis of learning style preferences revealed that auditory learning style had the highest average mean score (3.53), followed by visual (3.50), tactile (3.45), and kinaesthetic (3.44). These findings suggest that students prefer to learn mathematics through listening and observation. Auditory learners benefit from oral explanations, lectures, and discussions, while visual learners rely on diagrams, video tutorials, and other visual aids to understand concepts. Tactile and kinaesthetic learners, though slightly less dominant, still show a substantial preference for hands-on and experiential learning methods. These trends are consistent with prior research indicating that diverse learning modalities exist among students and should be catered for through multimodal teaching strategies.

ANOVA results testing the first hypothesis indicated a significant difference in students' academic performance based on their learning styles ($F = 49.642$, $p < 0.05$). This result implies that the way students prefer to learn significantly affects how well they perform in mathematics. Consequently, educators need to consider these preferences when designing and delivering instruction. Teaching methods that incorporate auditory and visual elements, such as multimedia lessons and oral explanations, are likely to be more effective for the majority of students.

Further analysis through an independent sample t-test showed a statistically significant difference in mathematics performance between male and female students ($t = 27.530$, $p < 0.05$), indicating that gender plays a role in learning outcomes. Male students, on average, performed better than their female counterparts. This gender disparity highlights the need for more inclusive and gender-sensitive pedagogical approaches that can support female students in overcoming barriers to learning mathematics.

However, the third hypothesis tested whether students' institutional affiliation influenced their performance. The results revealed no significant difference between students from Plateau State Polytechnic and Isa Mustapha Agwai Polytechnic ($t = 0.409$, $p = 0.473$). This suggests that the schools' learning environments and instructional delivery methods are comparable and that learning style preferences rather than institutional factors are more critical to academic success in mathematics.

These findings showcase the necessity for educators to be equipped with the knowledge and tools to identify and respond to students' learning preferences. While some students thrive in auditory or visual environments, others may require tactile or kinaesthetic engagement to fully comprehend mathematical concepts. Addressing these needs will reduce poor performance, disengagement, and dropout rates while fostering improved academic achievement across student populations.

CONCLUSION

The study concludes that polytechnic students in Nigeria predominantly prefer auditory and visual learning styles in the study of mathematics. These preferences significantly influence their academic performance. The findings emphasize the need for mathematics instructors to incorporate a variety of teaching methods that cater to these learning styles. By recognizing and addressing diverse learner needs, educators can improve student engagement, reduce failure rates, and support long-term academic and professional success in technical disciplines.

RECOMMENDATIONS

Based on the findings, the following recommendations are offered. Firstly, polytechnic educators should undergo professional development to help them recognize and integrate multiple learning styles into their teaching strategies. Secondly, teaching materials should be designed to include auditory and visual elements, such as instructional videos, diagrams, and podcasts, to support diverse learners. Thirdly, mathematics curricula should be reviewed to promote experiential learning that includes both abstract and hands-on applications. Lastly, institutions should establish mechanisms to regularly assess student learning preferences and adapt instructional methods accordingly to ensure continuous improvement in teaching and learning outcomes.

ACKNOWLEDGEMENT

The research work was made possible through a grant from Tertiary Education Trust Fund (TETFUND), Nigeria. The contents are solely the possibilities of the author and do not represent the official views of the funding organization. My appreciation goes to the sponsors, TETFUND and also the management of Plateau State Polytechnic, Barkin Ladi for their support.

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APPENDIX

Research Questionnaire
Biodata:
School ___________________________ Department ________________________
Gender____________________________

The following statements were designed to find out your preferred learning styles in mathematics. However, you tick the answer that describes your preferred learning style in mathematics in each question.

S/N	Question	Strongly Agree	Agree	Moderately Agree	Disagree	Strongly Disagree
1	I prefer to use graphs, charts, or diagrams to solve mathematical problems.					
2	I prefer to listen to audio explanations to learn mathematical concepts.					
3	I use kinaesthetic checklists or flowcharts to help with mathematical problem solving.					
4	I prefer to use manipulatives, such as counting bottle corks to learn mathematical concepts.					
5	I prefer to create and use physical model to learn or practice mathematical concepts.					
6	I prefer to use visual shapes and patterns to understand mathematical concepts.					
7	I use visual flowcharts to help with mathematical problem- solving					
8	I prefer to use visual aids like geometric shapes, numbers lines to help with mathematical calculations.					
9	I learn mathematical concepts better when they are presented in an audio format, such as lecture audio or recording.					
10	I learn mathematics better when I can touch and handle physical objects.					
11	I prefer to watch video tutorials to learn new mathematical concepts.					
12	I prefer to use audio recordings to review mathematical concepts or practice mathematical problems					
13	I prefer to use rhymes, songs, or raps to remember mathematical formulae or concepts.					
14	I prefer to learn mathematics through hands on experiments or activities.					
15	I prefer to use different colours or highlighting to organise or review mathematics notes.					
16	I prefer to use tactile aids, such as number lines to help with mathematical calculations.					
17	I prefer to work in a quiet environment with minimal distractions to focus on mathematical concepts.					
18	I prefer to create and use physical flashcards to review mathematical concepts.					
19	I learn mathematical concepts better when I can move around and engage in physical activities.					
20	I prefer to write mathematical problems or equations by hand.					
21	I learn mathematical concepts better when they are explained orally, such as in a one-on-one tutoring session.					
22	I create mental images or diagrams to solve mathematical words problems.					
23	I use kinaesthetic aids, such as movement cards or action diagrams to help with mathematical problem solving.					
24	I learn mathematical concepts better when I can create and manipulate physical models.					

S/N	Question	Strongly Agree	Agree	Moderately Agree	Disagree	Strongly Disagree
25	I prefer to engage in mathematical discussions or debates to deepen my understanding of mathematical concepts.					
26	I use tactile diagrams or charts to help with mathematics problem solving.					
27	I prefer to use visual models such as blocks or counting bears to present mathematical concepts.					
28	I learn mathematical concepts when they are presented in a step- by-step auditory formats.					
29	I prefer to work on mathematical problems or projects that involve building or constructing.					
30	I use tactile checklists or flow charts to help with mathematical problem solving.					
31	I prefer to use visual checklists or flowcharts to help with mathematical problem-solving.					
32	I learn mathematical concepts better when I act them out or use gestures.					
33	I use verbal self-talk or oral repetition to help with mathematical problem solving.					
34	I use real-life scenarios or applications to learn and practice mathematical concepts.					
35	I prefer to work with physical materials, such as play dough or clay to learn mathematical concepts.					
36	I prefer to engage in mathematical games or simulations that involves physical movement.					
37	I prefer to listen to mathematical explanations or tutorials in a slow deliberate pace					
38	I learn mathematical concepts better when I can use my body to represent mathematical relationships or concepts.					
39	I learn mathematical concepts better when I can use my hand to explore and discover mathematical relationships.					
40	I prefer to create concept maps or mind maps to organise and review mathematical concepts.					