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EDITORIAL

Journal of Innovations in Science Education (JISE) is a Publication of Association of Science Educators Anambra (ASEA). It is publishable both online and offline. The publication is twice a year. It embraces only on science education and innovative ideas. JIES provide an avenue for dissemination of research findings, innovative ideas and practices between researchers, science educators and policy makers in the form of original research, book review, theoretical and conceptual papers which will serve as an important reference for the advancement of teaching, learning and research in the field of science education.

We are grateful to the contributors and hope that our readers will enjoy reading these contributions.

Prof. Josephine N. Okoli
Editor-in-Chief

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EFFECT OF SENSORY-BASED INSTRUCTIONAL STRATEGY ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN MATHEMATICS IN OGIDI EDUCATION ZONE, ANAMBRA STATE

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Abstract

This study investigated the effect of Sensory-Based Instructional Strategy (S-BIS) on secondary school students' academic achievement in Mathematics in Ogidi Education Zone, Anambra State. Two research questions guided the study and two null hypotheses were tested at the 0.05 level of significance. The study adopted a quasi-experimental, pretest-posttest, non-randomized control group design. The population comprised 2,556 Senior Secondary School Two (SS II) students in the 29 co-educational public secondary schools in Ogidi Education Zone, Anambra State. A sample of 160 SS II students was drawn from two co-educational public secondary schools in two local government areas through a multistage sampling procedure. Mathematics Achievement Test (MAT) was used for data collection. The instrument was subjected to expert review by three lecturers, while it's internal consistency was established using the Kuder-Richardson Formula 20, which yielded a reliability coefficient of 0.83. The data were analysed using mean and standard deviation to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at the 0.05 level of significance. The findings indicated that students taught Mathematics using S-BIS had substantially higher achievement scores than those taught using the Conventional Lecture Method (CLM). The ANCOVA further showed a statistically significant main effect of teaching method on students' achievement. Gender did not have a statistically significant main effect, and the interaction effect between teaching method and gender was not statistically significant. The study concluded that S-BIS is a promising learner-centred approach for improving students' academic achievement in Mathematics and that its effectiveness did not significantly differ by gender in the present study. It was recommended, among others, that Mathematics teachers should be trained in the effective implementation of S-BIS and that schools should provide appropriate instructional materials, including mathematical models, manipulatives, charts and geometric solids, to support multisensory Mathematics instruction.

Keywords: Sensory-Based Instructional Strategy, Academic Achievement, Gender

Introduction

Education plays a critical role in the social, economic, and technological development of any nation. It serves as a fundamental tool for equipping individuals with the knowledge, skills, and competencies required for personal growth and national progress. Michael (2018) opined that education is the process by which societies reproduce and transform the knowledge and skills required for their functioning and development. A well-structured educational system enhances students' cognitive behavioural and emotional skills, preparing them to contribute meaningfully to society.

The Nigerian education system is structured into three main levels: basic education, secondary education, and tertiary education. Basic education comprises of 9 years of early childhood care, primary school education and junior secondary school, which together provide foundational knowledge in literacy, numeracy, and basic science (Ugobueze, 2024). Senior secondary school education in Nigeria is the final stage of secondary education, lasting three years (SS1 to SS3). It provides students with specialized knowledge in science, arts, and commercial subjects, preparing them for tertiary education or vocational careers.

Mathematics often described as the language of the universe, is a field of study concerned with the properties and relationships of numbers, shapes, and structures. It is a study that has evolved over millennia, touching every aspect of human life from the temporal to the permanent. At the basic level, Mathematics is about patterns and the logical relationships between them. Mathematics education fosters a growth mindset and the ability to approach problems creatively and innovatively (Boaler, 2016). The Boaler further maintained that Mathematics is essential for equity providing students with the necessary tools to succeed in a technology-driven society. This underlines Mathematics as a subject that plays a crucial role in the contemporary era of technology. This is because the algorithms that power search engines, data encryption, and even social media platforms are based on mathematical principles.

For instance, machine learning and artificial intelligence, which currently transform industries and daily lives, are grounded in statistical methods and linear algebra (Bishop, 2020). The Bishop added that Mathematics is a vast and dynamic field that spans the abstract and the practical and its development is evidence of human curiosity and ingenuity, providing tools to understand and shape the world. Mathematics can also be seen as a universal language that transcends cultural barriers and helps in the

development of global citizens who can collaborate and solve global issues effectively. As technology advances, the role of Mathematics in driving innovation and solving complex problems continues to grow, making it more relevant than ever.

Mathematics is one of the means of sharpening learner's minds, shaping their reasoning ability and developing their personality, hence its immense contribution to the general and basic education of the people of the world (Lessing & Ogbonnaya, 2026). Operationally, the researcher believes that Mathematics proficiency is essential for success in various academic and professional domains yet many students struggle to grasp mathematical concepts and develop problem-solving skills. Students' struggles to grasp mathematical concepts and failure to develop deep problem-solving abilities could be as a result of the teacher's method of teaching. According to Boaler (2022), when teachers focus primarily on right answers only rather than encouraging exploration and understanding, students often fail to see the relevance of developing problem solving abilities. Similarly, Hiebert and Grouws (2017) emphasized that teaching methods that promote reasoning, communication and conceptual understanding are more effective in helping students understand mathematical concepts.

Conventional methods of teaching like expository methods, lecture methods, discussion methods etc. often characterized by direct instruction, repetitive drills and passive learning appear to have been widely used by some Mathematics teachers years ago and are still being used by some Mathematics teachers in this modern time. Al-ghamdi and Holland (2020) stated that while these methods can be effective for procedural fluency, they fall short in engaging today's learners and nurturing deep conceptual understanding. Boaler (2016) opined that such approaches can lead to anxiety towards Mathematics and a fixed mindset where learners view mathematical ability as innate rather than developable. To address this, teachers are embracing innovative methods being introduced especially to science teachers, to help boost students' interest and draw their attention to the subjects being taught. These innovative methods of teaching are increasingly being adopted to make learning more meaningful, personalized and engaging. According to the Organisation for Economic Co-operation and Development (2018), students exposed to technology-enhanced, student-centered instruction methods of teaching, which are innovative methods, tend to perform better and report higher level of engagement. This suggests that innovative instructional strategies that integrate digital technologies such as sensory-based instructional strategies can improve learners' motivation, interest and participation in the learning process.

Sensory-based instructional strategies (S-BIS) is an instructional strategy or teaching approach that involves engaging students' senses (e.g sight ,sound, touch, taste, smell) to facilitate learning. It is a broader instructional approach that deliberately designs learning activities around students' sensory experiences and focuses on how sensory input is planned, organized and used to support learning outcomes. Tomlinson (2014), sensory-based instructional strategies are teaching approaches that engage learners through multiple sensory pathways, including visual, auditory, tactile and kinesthetic experiences, to improve understanding, participation and retention of learning. These strategies recognize that students learn more effectively when instruction accommodates different sensory preferences and learning styles. This approach can be incorporated into various teaching methods and can utilize a range of instructional materials and significantly improve the teaching and learning experience by making it more engaging, motivating, and effective.. It involves engaging students' senses of sight, touch, hearing, and sometimes smell or taste the learning process, allowing learners to internalize abstract concepts through direct perception. It cater to diverse earning styles, thereby fostering inclusivity, enhancing engagement and improving students understanding and interest in mathematics in the senior school classroom. Sousa (2022) defined sensory-based instructional strategies as instructional practices that intentionally stimulate more than one sense during learning by integrating visual materials, oral explanations, hands-on activities, movement and other sensory experiences to enhance cognitive processing, memory retention and meaningful learning. According to Sousa, learning becomes more effective when multiple areas of the brain are activated simultaneously through multisensory experiences. It also help demystify challenging topics by encouraging exploration and inquiry, promoting a deeper appreciation for the relevance of mathematics in daily life. Sensory-Based instructional strategies (S-BIS), especially multi-sensory approaches that engage visual, auditory, kinesthetic, and tactile senses, positively impact senior secondary students' understanding, engagement, and interest in mathematics.

This methods enhance learning outcomes and motivation compared to traditional approaches. Through touch, sight, and sometimes sound, learners engage actively with materials that bring abstract mathematical concepts to life. For instance, measuring liquids with graduated cylinders, comparing weights using balance scales, or handling cubes and containers to understand volume allows students to make meaningful connections between mathematical theory and the physical world. These approaches not

only enhance conceptual understanding but also support memory retention, problem-solving, and critical thinking skills (Anaso, 2025). Also, when students use their hands to explore, measure, and manipulate objects, they are not only gaining tactile feedback but also activating broader sensory pathways that include sight, motion, and even spatial awareness. Instead of relying solely on abstract exercises, learners can be encouraged to handle and measure familiar items such as household water reservoirs, cooking pots, and construction containers using measuring tapes, rulers, or other volume-related tools. For example, students might fill a cooking pot with water, feel the weight, observe changes in water level, and measure dimensions to calculate volume. This kind of interaction helps bridge the gap between theory and practice (Mayet, Alizadeh, Kakarash, Al-Qahtani, Alanazi, Alhashimi, Eftekhari-Zadeh & Nazemi, 2022). It not only sharpens mathematical skills but also makes learning more engaging and relatable. It also combines insights from different fields like psychology, and education, among others to make teaching and learning more engaging and rewarding. It presents the right atmosphere for engaging students in teaching and learning experiences by integrating multisensory channels into Mathematics instructions. By incorporating multisensory channels (visual, auditory, kinesthetic, and tactile senses) in teaching and learning Mathematics, mathematics educators can create a unique and interactive learning environment that fosters a deeper understanding of mathematical concepts and promotes critical thinking skills thereby improving students' learning engagement and interest.

Academic achievement according to Hill, Rowan and Ball (2018) refers to the level of success a student attains in their educational pursuits, typically measured through assessments such as examinations, tests, coursework, and overall academic performance. It reflects a student's ability to acquire knowledge, develop skills, and apply learning effectively in various subjects. Academic achievement is often evaluated using grades, standardized test scores, and other academic indicators to determine proficiency and progress (Geary, 2019). Academic achievement in mathematics is often measured by students' ability to apply mathematical reasoning, solve problems effectively, and demonstrate mastery of key concepts. However, achievement levels among students vary significantly due to differences in cognitive abilities, understanding, learning styles, engagement, interest and prior knowledge. It is on this note the study sought to investigate if sensory-based strategy minimize gaps in academic achievement, secondary school students' mathematics.

Statement of the Problem

Mathematics education in Nigerian secondary schools faces persistent challenges, characterized by poor student academic achievement and low retention of abstract concepts. In the Ogidi Education Zone of Anambra State, students frequently record low performance in mathematics during internal and external examinations like the West African Senior School Certificate Examination (WASSCE) from 2022 – 2025 results portal low academic achievement. This can attributed to frequently use traditional method of teaching and lack of mathematics teachers in the zone. Traditional teaching methods in this zone rely heavily on rote memorization, chalk-and-talk lectures, and abstract explanations. These conventional strategies fail to engage multiple human senses, making mathematics seem difficult, uninteresting, and abstract to learners. When instruction lacks tactile, visual, and auditory depth, learners struggle to connect mathematical symbols and formulas to real-world applications. Despite various curriculum reforms, the heavy reliance on teacher-centered instruction persists in many Ogidi secondary schools. This pedagogical gap contributes to persistent student anxiety, poor problem-solving skills, and underachievement in mathematics. If educators do not adopt active, engaging methods like sensory-based instructional strategies—which integrate visual, auditory, kinesthetic, and tactile experiences—poor performance in mathematics will likely continue. This study investigates whether implementing sensory-based instructional strategies can improve secondary school students' academic achievement in mathematics within the Ogidi Education Zone.

Purpose of the Study

The purpose of this study was to determine the effect of sensory-based instructional strategies on secondary school students' academic achievement, engagement and interest in Mathematics in Ogidi Education Zone of Anambra State. Specifically, the study determined;

1. Mean achievement scores of secondary school students taught mathematics using sensory-based instructional strategies and those taught using conventional lecture method.
2. The moderation of gender on the effect of sensory-based instructional strategies on students' achievement in mathematics.

Research Questions

The following research questions guided the study;

1. What is the mean achievement scores of secondary school students taught mathematics using sensory-based instructional strategies and those taught using conventional lecture method?
2. What is the moderation of gender on the effect of sensory-based instructional strategies on students' achievement in mathematics?

Hypotheses

The following hypotheses were tested at 0.05 levels of significance:

1. There is no significant difference between the mean achievement scores of secondary school students taught mathematics using sensory-based instructional strategies and those taught using conventional lecture method.
2. The moderation of gender on the effect of sensory-based instructional strategies on students' achievement in mathematics is not significant.

Methodology

The pretest-posttest non-randomized group quasi-experimental research design was adopted for this study. According to Igbokwe and Akinbola (2017), the design is used when investigating the effect of interventions on groups that have pre-existing conditions, such as varying levels of academic performance or socioeconomic status.

The study was conducted in Idemili- North Local Government Area (LGA) of Anambra State, Nigeria, with particular focus on the Ogidi Education Zone, which is one of the key educational districts within the LGA. Idemili- North LGA is made up of several towns, including Ogidi, Nkpor, Umuoji, Obosi, and Abatete and is predominantly a semi-urban area with a mix of public and private secondary schools. These schools provide a suitable environment for investigating instructional strategies and student learning outcomes, particularly in mathematics.

Ogidi Education Zone was selected as the focal point of this study because it represents a typical educational setting within Idemili- North LGA, offering a diverse population of secondary school students with varying academic abilities. The zone provides access to a manageable and representative sample of students, teachers, and schools, making it ideal for examining the effect of sensory-based instructional strategies on students' academic achievement, engagement and interest in mathematics. Conducting the study within this area ensures that the findings are grounded in the local educational context

while providing insights that could be relevant to other similar zones in Anambra State and beyond.

Idemili- North Local Government Area was chosen for this study because it provides a representative educational setting that is suitable for examining the impact of instructional strategies on student learning outcomes. The LGA, with its diverse secondary schools across towns such as Ogidi, Nkpor, Umuoji, Obosi, and Abatete, offers a balanced mix of urban and semi-urban populations, enabling the researcher to access students with varied academic abilities and learning experiences.

Specifically, the Ogidi Education Zone within Idemili-North LGA was selected due to its concentration of secondary schools, which facilitates efficient data collection and ensures that the sample is representative of the local student population.

The population of the study consisted of 2556 (1223 males and 1333 females) all the senior secondary school students in class two (SS2) in all the 29 public secondary schools in Ogidi education zone of Anambra state (Post Primary School Service Commission Statistics unit, 2025).

The sample of the study consisted of 160 (71 males and 89 female) SS2 Mathematics students drawn from two co-educational schools in two local government areas (Oyi and Idemili North), out of the 29 public schools in Ogidi Education Zone. The sample of the study was obtained using multistage sampling procedures. The samples were obtained first through simple random sampling techniques where two local government areas out of three local government areas in the zone were selected. This was to give each local government area an equal chance of being selected.

Secondly, a purposive sampling technique was used to select co-educational schools from the selected local governments. This was to get both male and female students under the same learning conditions. Thirdly, using simple random sampling technique, the researcher randomly picked from a bag containing the list of all co-educational schools, one school was selected from each local government making it a total of two schools. One of the schools was used as the control group while the other was used as the experimental group.

Finally, using simple random sampling, two arms in each of the selected schools were picked. This was done by folding the list of arms in the school in papers and picking. Each selected class was an intact group.

The instrument used for data collection was Mathematics Achievement Test (MAT). Each of the items was made up of two sections; section A which dealt with the demographic variable of the respondent while section B of MAT consisted of test items respectively.

The 50-item multiple-choice questions with four options contained in section B of the MAT were drafted from West African Senior School Certificate Examination (WASSCE) and National Examination Council (NECO) past questions and compiled based on the topics that were taught during the period of the research using a well-structured table of specification to ensure even coverage of content. In scoring, each correct answer attracts 2 marks while each wrong/unanswered question will be awarded zero. Hence, the highest score was 100 marks while the lowest score was zero. The MAT administered as a pretest was reshuffled and administered as a posttest.
The instruments were validated by three experts; two from the Department of Science Education and one from Measurement and Evaluation Unit of the Department of Education Foundations, all from the Faculty of Education Nnamdi Azikiwe University, Awka. These validators were asked to conduct face validity of the instrument and on the extent of coverage of the instrument on the topics under study. The experts were given the title, purpose, research questions, hypotheses, instruments for data collection as well as the lesson plans to vet. Corrections and suggestions given by the experts guided the production of the final drafts of the instrument.

Reliability of an instrument is the level of consistency of that instrument. To determine the reliability of the MAT, it was administered to an intact class of 40 SS2 students in one of the schools in Awka educational zone (another education zone outside the zone of study). The data collected was analyzed using Kuder-Richardson formula 20 (KR-20). The instrument contains multiple-choice objective questions that are dichotomously scored. The reliability coefficient for MAT was 0.83. The value was considered high enough for the instrument to be used for the study.

The researcher wrote to the respective school principals seeking their permission to carry out the study in their schools. When the permission was granted, the experiment was done in four stages for four weeks. During the research, the researcher took cognizance of extraneous variables.

The research questions were answered using mean and standard deviation scores while the hypotheses were tested at a 0.05 significant level using a Two-way Analysis of Covariance (ANCOVA).

Results

Research Question 1: What is the mean achievement scores of secondary students taught Mathematics using sensory-based instructional strategy and that of those taught using conventional lecture method?

Table 1: Mean Achievement Scores of Secondary School Students taught Mathematics using sensory-based instructional strategy(S-BIS) and conventional lecture method (CLM)

Sources of Variation	N	Pretest Mean	SD	Posttest Mean	SD	Mean Gain
S-BIS	80	42.50	6.20	74.80	7.10	32.30
CLM	80	42.10	6.05	58.60	6.80	16.50
Mean Difference	160	0.40	0.15	16.20	1.30	15.80

The results presented in Table 1 show that students taught Mathematics using the sensory-based instructional strategy had a pretest mean score of 42.50 with a standard deviation of 6.20, while their posttest mean score increased to 74.80 with a standard deviation of 7.10. This resulted in a mean gain of 32.30. On the other hand, students taught using the conventional lecture method recorded a pretest mean score of 42.10 with a standard deviation of 6.05 and a posttest mean score of 58.60 with a standard deviation of 6.80, producing a mean gain of 16.50. The table also shows that the difference between the pretest mean scores of the two groups is 0.40, indicating that both groups had nearly the same level of achievement before the treatment. However, after the instructional treatment, the posttest mean difference increased to 16.20 in favour of the sensory-based instructional strategy group. Furthermore, the difference in the mean gain scores between the two groups is 16.60, which also favour the students

taught using the sensory-based instructional strategy. This implies that students exposed to the sensory-based instructional strategy improved more in their Mathematics achievement than those taught using the conventional lecture method.

Research Question 2: What is the moderating effect of gender on the effect of Sensory-Based Instructional Strategies (S-BIS) on students' academic achievement in Mathematics?

Table 2: Moderating effect of gender on the effect of Sensory-Based Instructional Strategies (S-BIS) on students' academic achievement in Mathematics

Teaching Method	Gender	N	Pre test Mean	SD	Post test Mean	SD	Mean Gain
S-BIS	Male	34	42.70	6.30	75.20	7.10	32.50
S-BIS	Female	46	42.30	6.10	74.00	7.20	31.70
CLM	Male	37	42.20	6.05	59.10	6.80	16.90
CLM	Female	43	42.20	6.00	57.70	6.90	15.70

Table 2 shows that male students taught using Sensory-Based Instructional Strategies (S-BIS) had a pretest mean score of 42.70 with a SD of 6.30, while female students had a pretest mean score of 42.30 with a SD of 6.10. After treatment, their post-test mean scores were 75.20 with a SD of 7.10 for males and 74.00 with a SD of 7.20 for females, resulting in a mean gain scores of 32.50 and 31.70 respectively, indicating that both genders benefited substantially from the instructional strategy. Similarly, male students taught using Conventional Lecture Method (CLM) recorded a pre-test mean understanding score of 42.20 with a SD of 6.05 and female students had 42.00 with a

SD of 6.00 while their post-test mean scores increased to 59.10 with a SD of 6.80 and 57.70 with a SD of 6.90 yielding a mean gain scores of 16.90 and 15.17 respectively.

$H0_1$: There is no significant difference between the mean achievement scores of students taught Mathematics using Sensory-Based Instructional Strategies (S-BIS) and those taught using Conventional Lecture Method (CLM).

Table 3: ANCOVA on the Achievement Mean Scores of Students taught Mathematics using Sensory-Based Instructional Strategies (S-BIS) and those taught using Conventional Lecture Method (CLM).

Source	Type III SS	df	Mean Square	F	Sig.
Corrected Model	12560.84	2	6280.42	119.06	.000
Intercept	8425.16	1	8425.16	159.79	.000
Pretest	1535.21	1	1535.21	29.10	.000
Method	11025.63	1	11025.63	207.76	.000
Error	8280.40	157	52.74		
Corrected total	20841.24	159			
Total	298765.00	160			

R Squared = .603 (Adjusted R Squared = .598)

The result presented in Table 3 shows that the effect of teaching method on students' academic achievement of Mathematics was statistically significant, as indicated by the calculated F-value of 207.76 with a corresponding p-value of .000, which is less than the 0.05 level of significance $F(1, 157) = 207.76$, $p < .05$. This implies that there was a significant difference between the mean academic achievement scores of students taught Mathematics using Sensory-Based Instructional Strategies (S-BIS) and those taught using the Conventional Lecture Method (CLM), after controlling for the pre-test differences through ANCOVA. Since the p-value (.000) is less than the alpha level of 0.05, the null hypothesis was rejected. Therefore there is a significant difference between the mean academic achievement scores of students taught Mathematics using S-BIS and those taught using CLM in favour of the S-BIS group. The table also shows that the pre-test covariate was significant with $F(1, 157) = 119.06$, $p < .05$, indicating that students' pre-test scores significantly influenced their post-test academic achievement scores.

H0$_2$: The moderation of gender on the effect of Sensory-Based Instructional Strategies on secondary school students' academic achievement scores in Mathematics will not be significant.

Table 4: ANCOVA on the Moderation of Gender on the effect of Sensory-Based Instructional Strategies on Secondary School Students' academic achievement Scores in Mathematics.

Source	Type III SS	df	Mean Square	F	Sig.
Corrected Model	25846.81	4	6461.70	183.24	.000
Intercept	8250.34	1	8250.34	234.21	.000
Pretest	13450.42	1	13450.42	381.38	.000
Method	11240.58	1	11240.58	318.67	.000
Gender	120.45	1	120.45	3.41	.067
Method x Gender	85.36	1	85.36	2.42	.122
Error	5470.18	155	35.29		
Corrected Total	31316.99	159			
Total	39567.33	160			

R Squared = .24 (Adjusted R Squared = .22)

Table 4 points that the effect of teaching method on students' academic achievement in Mathematics was statistically significant, as indicated by the calculated F-value of 318.638with a corresponding p-value of .000, which is less than the 0.05 level of significance ($F = 318.67$, $p < .05$), while gender was not significant, as indicated by the calculated F-value of 3.41 with a corresponding p value of .067, which is greater than the 0.05 level of significance ($F = 3.41$, $p > 0.05$) and the interaction effect of method and gender was not statistically significant ($F = 2.42$, $p > 0.05$).This implies that there is no statistically significant difference in the moderation of gender on the effect of S-BIS on secondary school students' academic achievement scores in Mathematics after controlling for the pre-test differences through ANCOVA.

Since the significance value of the interaction effect ($p = .122$) is greater than 0.05, the null hypothesis was not rejected meaning that the moderation of gender on the effect of S-BIS on secondary school students' academic achievement score in Mathematics is not significant.

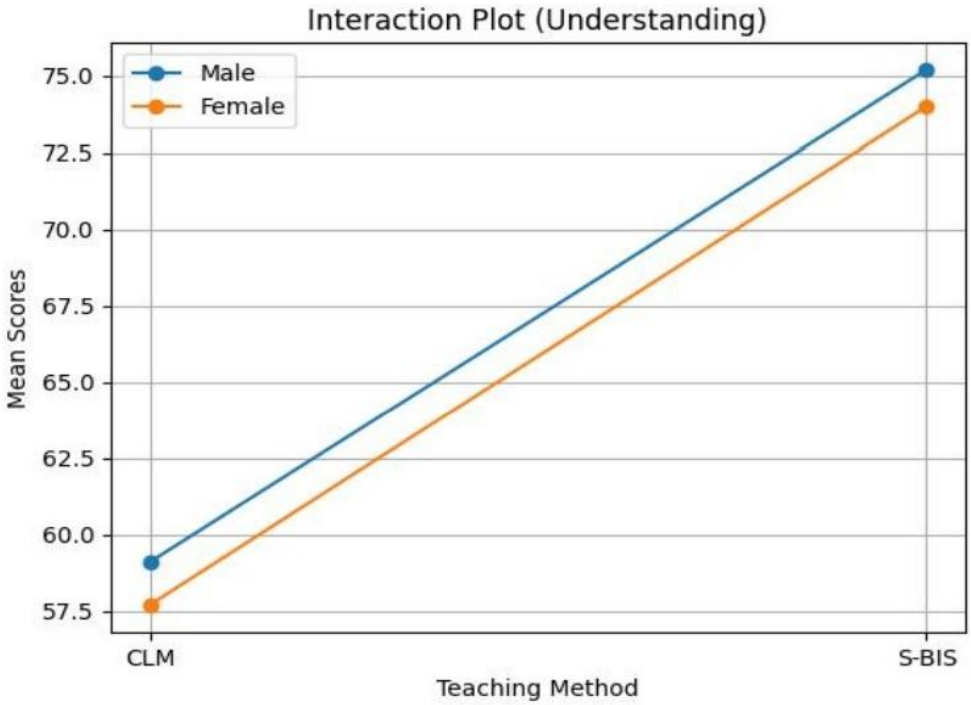

Figure 1: Plot of Interaction Effect of Teaching Method and Gender on Students' Academic Achievement Scores

The plot of interaction effect of teaching method and gender on students'mean academic achievement scores as shown in figure 2 presents the combined influence of Teaching Method (S-BIS and CLM) and Gender (Male and Female) on students' mean academic achievement scores in Mathematics. The lines are approximately parallel, indicating that gender did not significantly moderate the effect of teaching method on students' academic achievement scores.

Discussion

The findings of this study showed that there is a significant difference in the mean academic achievement scores of students taught Mathematics using sensory-based instructional strategies and those taught using expository method of teaching in favor of sensory-based instructional strategies. The students in sensory-based instructional strategies were engaged more than their counterparts taught using conventional lecture method of teaching. The ANCOVA results showed that the improvement in students' achievement was statistically significant after controlling for pretest scores, indicating that the observed difference resulted from the instructional strategy. This suggests that the integration of visual, auditory, tactile and kinesthetic learning experiences enhances students' conceptual understanding and academic performance in Mathematics. The finding is in line with Okafor, Ezeliora and Ifeanyi-Obiorah (2024), who found that the Jigsaw instructional strategy significantly improved senior secondary school students' achievement in Mathematics. Similarly, Oribhabor (2020) reported that activity-based instruction enhanced students' Mathematics achievement by promoting active participation and interaction with instructional materials. The finding also agrees with Olota and Olekanma (2025), who found that pupils exposed to the TouchMath multisensory programme achieved significantly higher computational skills than those taught using conventional methods. Although these studies employed different learner-centred instructional approaches, they collectively demonstrate that active learning strategies improve students' academic achievement in Mathematics.

This finding indicates that gender had no significant influence on students' academic achievement, learning engagement and interest in Mathematics when taught using Sensory-Based Instructional Strategies (S-BIS). The ANCOVA results showed that the slight differences observed between male and female students' posttest scores were not statistically significant. Similarly, the interaction effect between teaching method and gender was not significant, indicating that both male and female students benefited equally from the instructional strategy. The finding contradicts those of Ahmadu, Gambari, Abdul-Rasaq and Alabi (2017) and Abubakar and Ibrahim (2020), who reported significant gender differences in favour of male students in Mathematics achievement and attitude. However, the present finding agrees with Thompson, Uko and Oton (2025), who found that learner-centred multimedia instruction improved students' achievement and interest irrespective of gender. The present study extends this

evidence by incorporating visual, auditory, tactile and kinesthetic learning experiences, thereby providing a more inclusive instructional approach.

Conclusion

Based on the findings of the study, it was concluded that the sensory-based instructional strategy is an effective learner-centred instructional approach for improving secondary school students' academic achievement in Mathematics. The findings equally demonstrated that students taught using these Sensory-Based Instructional Strategies like integration of visual, auditory, tactile and kinesthetic learning experiences made Mathematics lessons more interactive, meaningful and enjoyable, thereby enhancing students' understanding and achievement in the learning process. The study further concluded that gender did not significantly influence students' academic achievement when Sensory-Based Instructional Strategies were employed. Therefore, teachers can confidently use Sensory-Based Instructional Strategy to teach Mathematics effectively to students regardless of gender.

Recommendations

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

1. Mathematics teachers should be trained through seminars, workshops and conferences on the effective use of Sensory-Based Instructional Strategies to improve students' academic achievement in Mathematics.
2. School administrators and relevant stakeholders should provide adequate sensory-based instructional materials such as mathematical models, manipulatives, charts, geometric solids and other teaching aids to facilitate the effective implementation of Sensory-Based Instructional Strategies in Mathematics classrooms.

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