EUROPEAN JOURNAL OF STEM EDUCATION

European Journal of STEM Education, 2026, 11(1), 18
eISSN: 2468-4368

lectito

Research paper

Enhancing Mathematics Retention through Seeing-AI: A Quasi-Experimental Study among Visually Impaired Junior Secondary Students in Ogun State, Nigeria

Akorede Ayoola Asanre [1*], Johnson Idowu Oguntola [2], Mamochana Anacletta Ramatea [1], Abisola Olusola Lawani [2]

[1] *University of Zululand,* SOUTH AFRICA
[2] *Tai Solarin Federal University of Education,* NIGERIA

*Corresponding Author: asanrea@unizulu.ac.za

Citation: Asanre, A. A., Oguntola, J. I., Ramatea, M. A., & Lawani, A. O. (2026). Enhancing mathematics retention through seeing-AI: A quasi-experimental study among visually impaired junior secondary students in Ogun State, Nigeria. *European Journal of STEM Education, 11*(1), 18. https://doi.org/10.20897/ejsteme/18268

Published: March 30, 2026

ABSTRACT

The persistent challenge of poor retention in Mathematics underscores the need for effective, 21st-century instructional strategies that can sustain students' long-term recall, particularly those students with visual impairment. The study examines the impact of gender and the Seeing AI method on the retention of mathematics among students with visual impairments in junior secondary schools in Ogun State, Nigeria. A quantitative approach to quasi-experimental design was employed. Purposive sampling was used to select two schools, 10 students each assigned to the experimental group and the control group. The Mathematics Retention Test (MRT), with a reliability coefficient of 0.82, was administered over three weeks alongside pre-test and post-test measures. Data were analyzed using Analysis of Covariance (ANCOVA). Findings revealed that Seeing AI had a statistically significant positive effect on students' Mathematics retention ($p < 0.05$). Gender did not exert a statistically significant main effect; however, there was a significant interaction effect between strategy and gender, indicating disparities in retention patterns across male and female students. The study concludes that Seeing-AI effectively enhances Mathematics retention among students with visual impairment, irrespective of gender differences. It recommends integrating this strategy into special education practices to ensure fairness and long-term effectiveness in learning.

Keywords: gender, mathematics, retention, seeing AI, students, visually impaired

Mathematics is widely recognized as the language of logic and structure, serving as the foundation for scientific, technological, and everyday problem-solving. Additionally, Mathematics is recognised as the language that underpins all other STEM disciplines as well as the medical and social sciences yet is accepted as a formidable discipline in its own right (Fitzmaurice et al., 2021). Beyond its academic role, Mathematics cultivates abstract reasoning and critical thinking, making it indispensable in modern society (Faruq, 2023; Asanre, 2024). Its relevance cuts across sectors such as commerce, engineering, medicine, and governance, where quantitative reasoning is essential for effective decision-making (Daroni et al., 2018; Al-Omoush et al., 2023).

Copyright © 2026 by the author(s). Licensed by Lectito Publications, Netherlands. This is an open-access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Despite its value, Mathematics continues to pose difficulties for many students, particularly students with visual impairments, who often struggle with its highly visual demands, such as interpreting graphs, diagrams, and symbols (Oyebanji & Idiong, 2021; Hayes & Proulx, 2024). Visually impaired students are defined as "a highly heterogeneous group whose most common characteristic is some degree of visual loss" (Parvin, 2015). According to Naipal and Rampersad (2018), these students experience reduced visual performance that cannot be fully corrected or restored, often resulting in functional limitations of the visual system. Consistent with these views, Munaw and Tegegn (2022) assert that visual impairment can have a profound impact on students' quality of learning if not addressed with appropriate care and support. Consequently, students with visual impairments are positioned within a range of challenges that can hinder their educational experiences and overall academic success.

A critical concern for this group of students is mathematical retention, which refers to the ability to recall and apply previously acquired knowledge (Valderama & Oligo, 2021). Because visual impairment often affects access to visual learning materials and symbolic representations, these learners may experience additional barriers to retaining mathematical concepts. Yeh et al. (2019) went further to confirm that retention is especially crucial because of Mathematics' hierarchical nature, where mastery of prior concepts determines success in new learning. Therefore, addressing the unique learning needs of visually impaired students is essential for supporting their sustained understanding and progression in Mathematics.

For visually impaired students, inadequate access to appropriate instructional resources often undermines retention, placing them at a disadvantage compared to their sighted peers (Ketema Dabi & Negassa Golga, 2024). Moreover, gender further complicates retention outcomes in Mathematics. Studies by Solomon and Oyem (2021), and Akinnodi and Ekpenyong (2022), suggest that male students tend to outperform female counterparts, a disparity often linked to gender stereotypes, unequal learning opportunities, and varying levels of classroom engagement. Conversely, other scholars (Lindberg et al., 2010; Abiodun et al., 2022; Asanre et al., 2024b) have found little or no significant difference when equitable instructional strategies are used. These conflicting findings underscore the importance of examining gender alongside innovative interventions for visually impaired students.

To address these epistemic challenges, educational systems have introduced assistive technologies such as Braille, tactile materials, and screen readers (Daroni et al., 2018). Recently, Artificial Intelligence (AI) has revolutionized inclusive learning by offering customized, adaptive, and real-time support tools (Shoaib et al., 2023). Acar et al. (2025) argues that the incorporation of artificial intelligence (AI) in personalized learning has redefined the educational process by providing an opportunity to personalize the instructions according to the needs, preferences, and learning speed of the individual students. Among these, Microsoft's Seeing AI has gained attention for its capacity to convert texts, objects, and symbols, including mathematical notations, into audio descriptions (Granquist et al., 2021). Studies conducted by Pundlik et al. (2023) and Shoaib et al. (2023) highlight its potential to transform mathematics instruction by offering auditory access to visual content, thereby enhancing comprehension, interaction, and long-term retention for visually impaired students.

In Nigeria, where visually impaired students consistently record poor performance in Mathematics, especially in retention-focused examinations like Basic Education Certificate Examination (BECE), compiled in Chief Examiner's Report (Examhall, 2024), empirical evidence on the effectiveness of Seeing AI remains limited. Most prior studies emphasize achievement rather than retention, leaving a gap in understanding how technology impacts long-term recall (Oyebanji & Idiong, 2021; Maćkowski et al., 2022; Al-Omoush et al., 2023). Moreover, little is known about how gender interacts with this AI tool in shaping mathematics retention outcomes among visually impaired students.

This study, therefore, investigates the effect of the Seeing AI strategy on Mathematics retention among visually impaired junior secondary school students in Ogun State, Nigeria. It specifically aims to explore whether gender influences retention outcomes when students are taught using Seeing AI compared to conventional methods. The study seeks to contribute evidence that can inform inclusive teaching practices, curriculum planning, and policy implementation in special education.

Objectives of the study

The objectives of the study are to:

1. Examine the effect of Seeing AI and conventional teaching methods on the retention of mathematical concepts among visually impaired junior secondary school students.
2. Investigate gender differences in retention among students taught with Seeing AI and conventional methods.
3. Examine the interaction effect of Seeing AI strategy and gender on Mathematics retention.

Research questions

 © 2026 by Author/s

1. What are the mean retention scores of visually impaired students taught Mathematics using Seeing AI and those taught using conventional methods?
2. What are the mean retention scores of male and female students taught Mathematics using Seeing AI?

Hypotheses

H_{01}: Seeing AI strategy has no significant effect on the retention of mathematical concepts among visually impaired junior secondary school students.

H_{02}: Gender has no significant effect on the retention of mathematical concepts among visually impaired junior secondary school students.

H_{03}: There is no significant interaction effect of Seeing AI strategy and gender on the retention of mathematical concepts among visually impaired junior secondary school students.

LITERATURE REVIEW

Concept of retention

Retention in education refers to the learner's ability to remember, recall, and apply previously acquired knowledge over time (Oguntola, 2025). In Mathematics, retention is especially critical because mastery of new concepts often depends on understanding earlier foundational knowledge (Yeh et al., 2019). For visually impaired students, challenges in accessing visual symbols, diagrams, and abstract notations make retention even more demanding (Ketema Dabi & Negassa Golga, 2024). Since retention is influenced by instructional methods, exposure frequency, and active participation in learning activities, studies indicate that retention can improve only when students are actively engaged through strategies that reduce cognitive barriers and support meaningful encoding of information (Pundlik et al., 2023; Shoaib et al., 2023). In the Nigerian context, where visually impaired students consistently show lower retention in Mathematics, as recorded in 2024 Chief Examiner's Report (Examhall, 2024), the use of assistive technologies such as Seeing AI has emerged as a potential solution to bridge this gap.

Influence of gender on retention

Gender remains an important factor in Mathematics education, with mixed findings reported across different studies. Some scholars argue that male students tend to retain mathematical concepts more effectively due to higher levels of confidence and societal expectations (Solomon & Oyem, 2021; Akinnodi & Ekpenyong, 2022). Conversely, others maintain that when instructional strategies are inclusive and equitable, gender differences in retention outcomes become negligible (Lindberg et al., 2010; Abiodun et al., 2022). In inclusive classrooms, the application of innovative instructional strategies such as AI-based tools can help balance gender outcomes, ensuring that both male and female students have equal opportunities to engage and recall mathematical content effectively (Asanre et al., 2024b).

Understanding visually impaired students' learning needs in mathematics

Visual impairment refers to a condition in which an individual's visual function is significantly reduced and cannot be fully corrected by standard lenses, surgery, or medical treatment (Naipal & Rampersad, 2018). The World Health Organization (WHO, 2023) categorises visual impairment into low vision and blindness, with both conditions influencing how students perceive, process, and interpret visual information. For visually impaired students, understanding mathematical concepts that are presented through graphs, symbols, diagrams, and other spatial representations that may pose significant challenges (Ketema Dabi & Negassa Golga, 2024; Samsuddin & Retnawati, 2018) Mathematics as a subject is heavily visual spatial, relying on abstract representations such as number lines, geometric figures, algebraic symbols and charts (Makamure & Jojo, 2021). A study of Mainali (2021) also shows that students with visual impairments experience challenges with conceptualizing spatial relationships, interpreting visual data, and understanding graphical representation.

Report from this study confirms that these difficulties often result in visually impaired students' slower cognitive processing, retention, and performance as compared to their sighted peers. However, Ketema Dabi & Negassa Golga (2024) reveal that visual impairment does not imply a lack of mathematical ability but the need to make use of necessary and adequate instructional materials and delivery methods. They went further to say that many visually impaired

© 2026 by Author/s

students demonstrate strong auditory memory, logical reasoning, and tactile perception, which can be harnessed through adapted instructional methods.

The place of AI as an assisted tool

Artificial intelligence has been characterized as the ability of a digital computer governed by an operating system to carry out a task to complement human effort (Asanre et al., 2024a). Additionally, Bin-Mohamed et al. (2022) opined that Artificial Intelligence is the capability to recognize patterns, make decisions, learn from experience, and adapt to changes. This innovation has been identified to transform how mathematics is taught and learned by reducing the cognitive load on students, especially those with visual impairment. Ensuring that the abstract nature of mathematics, which is challenging, becomes more interactive and engaging. Ahmet and Faith (2020) established that the extensive growth of artificial intelligence has an impact on the educational and administrative procedures in classrooms and schools. Saputra et al. (2023) submitted that using artificial intelligence teachers facilitate preventive and subsequent actions that help students meet learning objectives. The arrival of artificial intelligence creates room for critical thinking, creativity, smartness, and skills needed in the 21st century. Hence, Granquist et al. (2021) emphasize that AI-powered tools such as Seeing-AI support visually impaired students, offering real-time assistance in solving problems, thus enhancing accessibility and engagement. Also, Shoaib et al. (2023) concluded that AI-powered tools assess students' learning patterns and adjust instructional content moderately, thereby promoting more effective learning experiences.

Framing mathematics retention through cognitive load and inclusive special education theories among visually impaired students

Sweller's (1988) Cognitive Load Theory (CLT) serves as the foundation for this investigation. CLT emphasizes that learning is shaped by the limitations of working memory and the capacity of long-term memory. Three categories of cognitive burden are distinguished by it: intrinsic, external, and germane (Leppink & Van den Heuvel, 2015). Good instructional design reinforces relevant load, controls intrinsic burden, and minimizes superfluous load, which supports schema construction for long-term retention. For visually impaired learners, CLT highlights the need for adaptive instructional strategies that distribute content across multiple sensory channels, such as auditory and tactile modalities (Ginns & Leppink, 2019).

The Seeing AI application aligns with these principles by presenting mathematical information through multimodal formats like audio narration and tactile guidance. It reduces extraneous load by simplifying content delivery, manages intrinsic load through stepwise explanations, and enhances germane load by encouraging active engagement with mathematical problems (Sweller et al., 2011). AI's ability to provide adaptive scaffolding resonates with CLT's call for progressive guidance, enabling learners to develop robust schemas at their own pace (Duran et al., 2022). For visually impaired students, such scaffolding is critical in overcoming challenges inherent in processing abstract mathematical concepts.

While Cognitive Load Theory (CLT) emphasizes optimizing learners' mental processing to enhance understanding and retention (Sweller, 1988), its principles provide a valuable foundation for Inclusive Special Education, which seeks to adapt teaching approaches to meet the diverse cognitive and learning needs of all students (Garcia & Toledo, 2020). Inclusive special education focuses on ensuring that all learners, regardless of abilities or disabilities, have access to mainstream classrooms (Raguindin et al., 2021). It emphasizes equity, participation, and the adaptation of teaching strategies to accommodate diverse learning needs. Inclusive special education theory is therefore relevant since it has often been used, especially to determine teachers' and schools' readiness for inclusive education practices among visually impaired students.

Aligning Cognitive Load Theory (CLT) with the Inclusive Special Education framework provides a central lens for enhancing mathematics retention for visually impaired students through Seeing-AI. Since the inclusive education framework emphasizes the right to every student to learn (Landsberg et al., 2019), the best way to achieve this right relies on assistive tools that encourage engagement and equity of learning. According to Hornby (2020), the inclusive special education framework considers the implementation of a well-established and arange of inclusive teaching practices specifically designed for the needs of individuals with special educational needs and disabilities that are implemented by well-trained special education teachers.

CLT, on the other hand, highlights how the human cognitive system processes, stores, and retrieves information, emphasizing the need to optimize learning while minimizing unnecessary mental effort (Leppink & Van den Heuvel, 2015). It distinguishes between intrinsic load (the inherent complexity of mathematical content), extraneous load (imposed by poorly designed instruction), and germane load (effort devoted to building understanding).

 © 2026 by Author/s

Central to these theories is the belief that enhancing mathematics retention among visually impaired students requires recognition and the interaction between cognitive processing in a well-designed teaching practice. This calls for a shift from a deficit view of visual impairment as a weakness to a strength-based approach among this category of students, an inclusive approach such as Seeing -AI that values their diverse ways of knowing and understanding concepts in mathematics. This also forms the foundation for leveraging seeing-AI to enhance mathematics retention among visually impaired students.

This paper considers the application of CLT within an inclusive special education context as appropriate to bring instruction that can reduce extraneous load through accessible tools like Seeing-AI and enhance germane load, allowing students to focus on understanding concepts rather than struggling with inaccessible materials. This integration supports equitable learning, assistive devices, and the effective use of assistive seeing AI, thereby promoting better retention in mathematics for visually impaired students.

Both theoretical frameworks serve as a standpoint to establish the theoretical prediction of a reduction in cognitive load that is associated with visual understanding of mathematical content among visually impaired learners to improve mathematics retention associated with the germane cognitive process. To achieve this, empirical evidence is required to control learners' prior knowledge. Which influences the need for an appropriate design, such as a pretest, posttest, and control group quasi-experimental design. This design ensures a balance between methodological rigor and inclusive education practice. Furthermore, analysis of covariance is used to reinforce causal interpretation and statistically correct posttest results for pretest differences, ensuring that the study evaluates theoretical assumptions in an inclusive learning environment (Tabachnick & Fidell, 2019).

Empirical review

Research has consistently shown that artificial intelligence can enhance learning outcomes for students with visual impairments. Ashfin (2023) reported that 90% of visually impaired students using AI tools experienced improved accessibility, while 75% gained greater independence through object recognition features. AI interventions also boosted engagement by 40% and reduced teachers' workload by 30%, highlighting their dual benefit for learners and educators. Similarly, Xue and Barker (2022), in a study by the Northwest Evaluation Association (NWEA), found that 75% of visually impaired students lag behind their peers in Mathematics, emphasizing the importance of accessible digital tools.

Specific studies on Seeing AI further confirm its educational value. Granquist et al. (2021) demonstrated that the app achieved over 95% accuracy in reading printed text, allowing visually impaired learners to complete more than half of their assigned academic tasks independently. Although challenges remain with stylized text, the findings underscore its potential for supporting comprehension and retention in Mathematics when paired with teacher guidance. Collectively, these studies indicate that AI, and Seeing AI, can promote retention by improving accessibility, fostering engagement, and supporting inclusive learning for visually impaired students.

METHODOLOGY

Pre-test, delayed post-test, and control groups were all included in the study's quasi-experimental design, which was a non-equivalent control group design. This design was chosen because intact groups were used without random assignment, a decision guided by ethical and practical considerations, especially given the vulnerable population of visually impaired students. Quasi-experimental designs are widely applied in inclusive education research and are appropriate for evaluating instructional strategies with special populations (Maćkowski et al., 2022). Showing evidence in the theoretical frameworks that underpinned the study. The quasi-experimental design enables the empirical examination of this theoretical claim by comparing mathematics retention outcomes between students exposed to Seeing-AI-supported instruction and those receiving conventional instructional support. By employing pre-test and post-test measures, the design allows for the observation of changes in retention that can be attributed to differences in cognitive load management facilitated by the intervention.

The population included every student enrolled in Junior Secondary School II (JSS II) with visual impairments in the Ijebu-Ode and Ijebu-Igbo Local Government Areas of Ogun State. Using purposive sampling, two schools were chosen that enrolled visually impaired learners in JSS II Mathematics. One school served as the experimental group, where students were taught using the Seeing AI strategy, while the other functioned as the control group, where instruction was delivered through conventional methods. Each school's intact JSS II class comprised 10 visually impaired students, all of whom met the inclusion criteria of having diagnosed visual impairment and being enrolled in JSS II Mathematics.

© 2026 by Author/s

The research tools were developed for data collection. The first was the Mathematics Retention Test (MRT), designed to measure students' retention of algebraic expression concepts. The MRT consisted of 15 multiple-choice questions covering variables and constants, simplification, evaluation with given values, collection of like terms, expansion, factorization, and solving equations. The items were sequenced in increasing difficulty and aligned with the JSS II Mathematics curriculum. Accessibility was ensured through Braille and audio formats. Expert reviews by specialists in Mathematics education and special education confirmed the clarity, curriculum compliance, and appropriateness of the test for visually impaired learners. Reliability was established through test–retest using the Pearson Product-Moment Correlation Coefficient (PPMC), which yielded a coefficient of 0.82. The second instrument was the Seeing AI Instructional Guide, which provided structured scaffolding to enable independent engagement with algebraic concepts. Professionals in special education and mathematics validated this guide.

The study procedure was carried out in three stages. First, permissions and ethical clearances were obtained from school authorities, along with parental/guardian consent for student participation. The objectives, procedures, and benefits of the study were explained orally to participants, and confidentiality and voluntary participation were assured. Next, a pre-test was administered one week before treatment to establish group homogeneity. The experimental group received instructions utilizing the Seeing AI technique during the three-week treatment phase, whereas the control group continued to receive traditional instruction. Finally, a delayed post-test was conducted three weeks after the intervention to measure retention.

Data was analyzed using descriptive statistics (Mean, Standard Deviation) and inferential analysis through Analysis of Covariance (ANCOVA), which enabled comparisons between groups while controlling for post-test scores and testing for treatment, gender, and interaction effects. The justification for the use of ANCOVA was established by ensuring the linear relationship between the covariate and the dependent variable to ensure meaningful adjustment. To guarantee a fair comparison of adjusted averages, the connection between prior knowledge and retention was also examined by testing the interaction between group membership and pretest score. For proper comparison, purposive sampling was used to ensure that participants meet clearly defined inclusion criteria to strengthen construct validity. Also, this helps to control maturation and external events unrelated to the intervention.

RESULTS

Research question one: What are the mean retention scores of visually impaired students taught Mathematics using the Seeing AI strategy and those taught using conventional methods? **Table 1** presents the descriptive statistics of the retention test scores. The experimental group obtained a higher mean score (M = 11.20, SD = 1.81) compared to the control group (M = 8.10, SD = 0.88). This indicates that students exposed to the Seeing AI strategy retained more mathematical knowledge over time than those taught with conventional methods.

Table 1

Descriptive Statistics of Retention Test Scores

Group	Number	Mean	Standard Deviation
Experimental (Seeing AI)	10	11.20	1.81
Control (Conventional)	10	8.10	0.88

Research question two: What are the mean retention scores of students exposed to the Seeing AI strategy in terms of gender? As shown in **Table 2**, male students achieved a higher mean score (M = 13.25, SD = 0.83) compared to female students (M = 9.83, SD = 1.07). Although both genders benefited from the intervention, the results suggest that male students demonstrated slightly stronger retention with more consistency than female students.

Table 2

Mean and Standard Deviations of Retention Scores by Gender

Gender	Mean Retention Score	Standard Deviation Retention Score
Male	13.25	0.83
Female	9.83	1.07

© 2026 by Author/s

Hypothesis one: The Seeing AI strategy does not significantly affect the academic retention of visually impaired junior secondary school students in Mathematics.

The ANCOVA results in **Table 3** revealed a significant main effect of instructional strategy on students' retention, $F_{(1, 19)} = 35.04$, $p < .05$. Consequently, the null hypothesis was rejected, indicating that the Seeing AI strategy significantly improved Mathematics retention among visually impaired students.

Table 3

Two-way Analysis of Covariance (ANCOVA) of Students' Retention Scores by Treatment, Gender and Interaction, Controlling Post-Test Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	83.192a	4	20.798	27.468	.000
Intercept	14.643	1	14.643	19.338	.001
Post-test	7.026	1	7.026	9.279	.008
Strategy	26.524	1	26.524	35.029	.000
Gender	6.251	1	6.251	8.256	.126
Strategy * gender	12.202	1	12.202	16.114	.001
Error	11.358	15	.757		
Total	1957.000	20			
Corrected Total	94.550	19			

a. R Squared = .880 (Adjusted R Squared = .848)

Hypothesis two: Gender has no significant effect on the academic retention of visually impaired junior secondary school students in Mathematics.

The results showed no significant main effect of gender, $F_{(1, 19)} = 8.26$, $p > .05$. The null hypothesis was therefore retained, confirming that gender did not significantly influence retention outcomes.

Hypothesis three: The interaction of gender and the Seeing AI strategy has no significant effect on the academic retention of visually impaired junior secondary school students in Mathematics.

Findings revealed a significant two-way interaction effect between instructional strategy and gender, $F_{(2, 19)} = 16.11$, $p < .05$. This suggests that the effect of the Seeing AI strategy on retention varied by gender, leading to the rejection of the null hypothesis.

DISCUSSION

The results from the first research question revealed that the Seeing AI strategy significantly enhanced students' retention of mathematical concepts. This improvement is attributed to the strategy's repetitive and multimodal exposure, which allowed students to revisit and engage with mathematical content beyond classroom hours. By enabling on-demand review, Seeing AI supported spaced repetition and retrieval practice, both of which are essential for long-term memory. This finding corresponds with Sweller's Cognitive Load Theory and Inclusive Special Education Theory, which posits that technology can minimize extraneous cognitive load to improve sustained learning among visually impaired students, fostering equity and quality education. Similarly, Szabo et al. (2020) affirmed that innovative strategies such as AI foster long-term learning, while Zhu et al. (2025) demonstrated that AI-powered interventions significantly enhance long-term mathematics performance.

The second research question examined the role of gender in retention. Findings revealed that male students achieved slightly higher retention scores than their female counterparts after exposure to the Seeing AI strategy. This difference may be attributed to varying engagement levels or ease of interaction with the tool across genders. These results are consistent with Udonsa (2015) and Zakariya et al. (2016), who observed gender-based differences in Mathematics retention. Nevertheless, the outcome underscores the need for gender-sensitive instructional practices that ensure equity in retention outcomes.

In relation to the first hypothesis, results confirmed that the Seeing AI strategy had a statistically significant positive effect on students' mathematics retention. This improvement is linked to the tool's audio features, which enabled learners to revisit explanations independently, reinforcing learning at their own pace (Gjini & Hernandez-Gantes, 2025). This supports the work of Sweller et al. (2011) and Xue and Barker (2022), who reported that AI-based tools reduce cognitive load and enhance mathematics memory, especially for visually impaired learners. Similarly, Yeh et al. (2019), Szabo et al. (2020), Xu (2024), and Zaman (2023) documented that AI-supported learning environments strengthen both immediate understanding and long-term retention.

© 2026 by Author/s

Regarding the second hypothesis, results showed that gender had only a slight, non-significant effect on mathematics retention. Although male students achieved higher mean scores, both genders benefited equally from the Seeing AI strategy. This finding aligns with Yadav (2019), Wang and Degol (2017), and Sule and Sunday (2024), who reported that gender differences in Mathematics achievement are often negligible when inclusive, technology-enhanced approaches are applied (Chen et al., 2025). The Seeing AI tool may have equalized outcomes by providing personalized auditory input, thereby granting male and female students equal opportunities to reinforce concepts.

Finally, the study revealed an interaction effect between gender and the Seeing AI strategy on retention outcomes. This suggests that while the tool improved retention across genders, its effectiveness varied slightly based on learner characteristics such as engagement style, prior exposure to assistive technologies, or personal interest (Borlio & Duping, 2026). This observation corroborates Zaman (2023) and Zhu et al. (2025), who emphasized that gender could influence how students benefit from AI-based learning tools. Sinay and Nahornick (2016) further noted that gender-based learning behaviors and attitudes may shape how technology is utilized in Mathematics classrooms.

CONCLUSIONS

The study concludes that the Seeing AI strategy significantly improves Mathematics retention among visually impaired junior secondary school students. Students taught with the strategy outperformed those taught with conventional methods, demonstrating its effectiveness as a 21st-century instructional tool. Despite the male having somewhat higher mean scores than their female counterparts, the difference was not statistically significant, confirming the inclusivity of the strategy across genders. Thus, the Seeing AI tool stands as a powerful approach for improving long-term mathematical understanding and recall among visually impaired students in Ijebu-Ode and Ijebu-Igbo, Ogun State.

The study recommends the integration of the Seeing AI strategy into Mathematics instruction for visually impaired learners. Teachers should be adequately trained and motivated to adopt AI tools, while schools should provide functional smartphones, reliable internet access, and ongoing technical support. Policymakers and school administrators should also encourage the use of assistive technologies in inclusive education to promote equity, deepen learning engagement, and enhance long-term retention. The study was limited by its relatively small sample size of 20 students, which restricts the generalization of results. Additionally, not all students in the experimental group had personal smartphones, requiring device sharing during lessons. Some participants also faced initial difficulties navigating the Seeing AI application due to low digital literacy, which necessitated preliminary training sessions. This limitation did not disrupt the efficacy of the strategy, contributing more that 80% of the effect on students' achievement.

Acknowledgement

The authors express appreciation to the participating schools, students, and teachers for their cooperation throughout the study. Also appreciate the University of Zululand and Tai Solarin Federal University of Education.

Funding

The research did not receive any funding.

Ethical statement

Permissions and ethical clearances were obtained from school authorities, along with parental/guardian consent for student participation.

Competing interests

The authors declare no conflict of interest.

Author contributions

Asanre, A. A. responsible for research concept and design, critical revision of the article, and final approval; Oguntola, J. I. responsible for writing the article and collection of data; Ramatea, M. A. responsible for critical revision and final approval of the article. Lawani, A. O. responsible for critical revision of the article.

 © 2026 by Author/s

Data availability

Data that support the findings of this study are available from the corresponding author upon reasonable request.

AI disclosure

AI was not used in writing articles. It was only used in sentence structure example of AI used is Grammarly

Biographical sketch

Akorede Ayoola Asanre a native of Isara Remo, Ogun State and a dedicated Mathematics education educator with a Ph.D. in Mathematics Education. I am a Postdoctoral researcher fellow at the University of Zululand, South Africa, and a Senior Lecturer in the department of Mathematics, Tai Solarin Federal University of Education, Nigeria. I am a member of several professional organizations, including the Nigerian Mathematical Society, Mathematics Association of Nigeria, and the Science Teacher Association of Nigeria. My research interests include cognitive and non-cognitive students' variables, student engagement, learning outcomes, teacher's factors and innovative teaching strategies

Johnson Idowu Oguntola, a dedicated Mathematics educator and advocate for inclusive education, with over 17 years of teaching experience. I currently teach Mathematics at Federal Technical College, Itamogiri, Ijebu-Imusin, Ogun State, Nigeria, I hold an M.Sc. (Ed) from Tai Solarin Federal University of Education, Ijebu-ode, Ogun State, Nigeria. I also possess a B.Sc. (Ed) in Mathematics from Ekiti State University and an NCE in Education for the Visually Impaired and Mathematics from the Federal College of Education (Special), Oyo. I am deeply committed to advancing inclusive, innovative, and equitable STEM education in Nigeria and beyond

Dr Mamochana Anacletta Ramatea is a Part-time Lecturer and Postdoctoral Research Fellow in the Department of Psychology of Education and Special Education, Faculty of Education, University of Zululand, South Africa. She holds a Ph.D. in Psychology of Education from the University of the Free State, South Africa. Her scholarly expertise is situated within educational psychology and inclusive education. Her key research interests include inclusive education for learners with visual impairments, educational psychology in rural contexts, teacher agency and support mechanisms, and the application of asset-based and decolonial approaches to enhance equitable learning environments.

Professor Abisola Olusola Lawani is a Professor of Mathematics Education in the Department of Mathematics, College of Science and Information Technology, Tai Solarin Federal University of Education, Ijagun, Nigeria. She holds a Ph.D. in Mathematics Education from Olabisi Onabanjo University, Nigeria. Her primary expertise lies in mathematics education, with a strong focus on improving teaching and learning outcomes. Her key research interests include mathematics teaching and learning strategies, curriculum development and evaluation, and the integration of innovative pedagogies in mathematics classrooms.

Disclaimer/Publisher's Note

The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and do not necessarily reflect the views of Lectito Publications and/or the editor(s). Lectito Publications and/or the editor(s) disclaim responsibility for any injury to persons or property resulting from any ideas, methods, instructions, or products referred to in the content.

REFERENCES

Abiodun, T. O., Asanre, A. A., Ogundeji, M. A., Odupe, T. A., & Rasaki, M. G. (2022). Effect of think-pair-share strategy on student achievement in senior secondary school mathematics. *FNAS Journal of Mathematics and Science Education, 3*(2), 20–25. http://www.fnasjournals.com/

Acar, E., Yigit, F., & Deiri, Y. (2025). A focused review of artificial intelligence in education: Evolution and challenges. *Journal of Interdisciplinary Research in Artificial Intelligence and Society, 1*(1), 3. https://doi.org/10.20897/jirais/17640

Ahmet, G., & Fatih, A. (2020). Artificial intelligence in education and schools. *Research on Education and Media, 12*(1), 13–21. https://doi.org/10.2478/rem-2020-0003

Akinnodi, P. A., & Ekpenyong, S. I. (2022). Gender difference in mathematics achievement among senior secondary school students in Ondo West Local Government Area of Ondo State, Nigeria. *Quest Journal of Research in Humanities and Social Science, 10*(3), 20–23. https://www.questjournals.org/jrhss/papers/vol10-issue3/Ser-4/D10032023.pdf

© 2026 by Author/s

Al-Omoush, M. H., Salih, S. E., & Mehigan, T. (2023). Technology-enhanced inclusive mathematics learning: Promoting equity and lifelong learning opportunities for vision-impaired students. *2023 IEEE International Humanitarian Technology Conference (IHTC, 1)*, 1–6. https://doi.org/10.1109/IHTC.2023.XXXX

Asanre, A. A. (2024). Motivational factors as determinant of mathematics achievement of students in senior secondary schools. *Interdisciplinary Journal of Education Research, 6*, 1–9. https://doi.org/10.38140/ijer-2024.vol6.19

Asanre, A. A., Aviwe, S., Ogunyale, A., Olusola, G., & Sottin, D. (2024b). Effect of integrating YouTube as a teaching tool on the academic achievement of senior secondary school students in mathematics. *FNAS Journal of Mathematics and Science Education, 5*(2), 82–86. http://www.fnasjournals.com/

Asanre, A. A., Taiwo, T. O., & Odupe, T. A. (2024a). Teachers' perception towards the integration of artificial intelligence in the teaching of mathematics in senior secondary school. *Jurnal Pendidikan Matematika dan Sains, 12*(2), 154–161. https://dx.doi.org/10.21831/jpms.v12i2.77349

Ashfin, U. (2023). Using AI for visual impairment assistance in schools. *Multidisciplinary Science Journal, 1*(1), 13–19. https://www.neliti.com/publications/590999/using-ai-for-visual-impairment-assistance-in-schools#cite

Bin-Mohamed, M. Z., Hidayat, R., Binti-Suhaizi, N. N., Bin-Mahmud, M. K. H., & Binti-Baharuddin, S. N. (2022). Artificial intelligence in mathematics education: A systematic literature review. *International Electronic Journal of Mathematics Education, 17*(3), 694. https://doi.org/10.29333/iejme/12132

Borlio, J., & Duping, A. (2026). Rowing different boats in the same troubled sea: A voyage on flexible learning. *American Journal of Qualitative Research, 10*(1), 61–78. https://doi.org/10.29333/ajqr/17460

Chen, Y., Ku, Y.-R., & Lu, J. (2025). Cross-cultural validation of the short math anxiety scale among Chinese high school students. *Journal of Ethnic and Cultural Studies, 12*(4), 1–19. https://doi.org/10.29333/ejecs/2108

Daroni, G. A., Gunarhadi, G., & Legowo, E. (2018). Assistive technology in mathematics learning for visually impaired students. *Tadris: Jurnal Keguruan dan Ilmu Tarbiyah, 3*(1), 1–9. https://doi.org/10.24042/tadris.v3i1.2406

Duran, R., Zavgorodniaia, A., & Sorva, J. (2022). Cognitive load theory in computing education research: A review. *ACM Transactions on Computing Education (TOCE), 22*(4), 1–27. https://doi.org/10.1145/3483843

Examhall. (2024). *BECE chief examiner's report for mathematics: Candidates' strength, weakness and recommendations.* https://examhall.org/exam-study-tips/bece-chief-examiners-report-for-Mathematics/

Faruq, I. U. (2023). The impact of pure and applied mathematics to the society: Nigeria as a case study. *Cosmos Journal of Engineering & Technology, 13*(2). https://doi.org/10.46360/cosmos.et.620232006

Fitzmaurice, O., O'Meara, N., & Johnson, P. (2021). Highlighting the relevance of mathematics to secondary school students: Why and how. *European Journal of STEM Education, 6*(1), 07. https://doi.org/10.20897/ejsteme/10795

Garcia, M. M., & Toledo, L. D. (2020). The elements of an inclusive educational system as seen from the perspective of teachers. *Psicologia Escolar e Educacional, 24*. http://dx.doi.org/10.1590/2175-35392020220328

Ginns, P., & Leppink, J. (2019). Special issue on cognitive load theory. *Educational Psychology Review, 31*, 255–259. https://doi.org/10.1007/s10648-019-09474-4

Gjini, T. W., & Hernandez-Gantes, V. M. (2025). Who gets to intern? Demographic and institutional predictors of internship participation among international students. *European Journal of Education & Language Review, 1*(1), Article 1. https://doi.org/10.20897/ejelr/17312

Granquist, C., Sun, S. Y., Montezuma, S. R., Tran, T. M., Gage, R., & Legge, G. E. (2021). Evaluation and comparison of artificial intelligence vision aids: Orcam My Eye 1 and Seeing AI. *Journal of Visual Impairment & Blindness, 115*(4), 277–285. https://doi.org/10.1177/0145482X211027492

Hayes, C., & Proulx, M. J. (2024). Turning a blind eye? Removing barriers to science and mathematics education for students with visual impairment. *British Journal of Visual Impairment, 42*(2), 544–556. https://doi.org/10.1177/02646196221149561

Hornby, G. (2020). The necessity of coexistence of equity and excellence in inclusive and special education. *Oxford Research Encyclopedia of Education*. https://doi.org/10.1093/acrefore/9780190264093.013.1231

Ketema Dabi, G., & Negassa Golga, D. (2024). The role of assistive technology in supporting the engagement of students with visual impairment in learning mathematics: An integrative literature review. *British Journal of Visual Impairment, 42*(3), 674–687. https://doi.org/10.1177/02646196231158922

Landsberg, E., Kruger, D., & Swart, E. (2019). *Addressing barriers to learning: A South African perspective*. Van Schaik.

Leppink, J., & Van den Heuvel, A. (2015). The evolution of cognitive load theory and its application to medical education. *Perspectives on Medical Education, 4*, 119–127. https://doi.org/10.1007/s40037-015-0192-x

Lindberg, S. M., Hyde, J. S., Petersen, J. L., & Linn, M. C. (2010). New trends in gender and performance in mathematics: A meta-analysis. *Psychological Bulletin, 136*(6), 1123–1135. https://doi.org/10.1037/a0021276

 © 2026 by Author/s

Maćkowski, M., Żabka, M., Kempa, W., Rojewska, K., & Spinczyk, D. (2022). Computer aided math learning as a tool to assess and increase motivation in learning math by visually impaired students. *Disability and Rehabilitation: Assistive Technology, 17*(5), 559-569. https://doi.org/10.1080/17483107.2020.1800116

Mainali, B. (2021). Representation in teaching and learning mathematics. *International Journal of Education in Mathematics, Science, and Technology (IJEMST), 9*(1), 1–21. https://doi.org/10.46328/ijemst.1111

Makamure, C., & Jojo, Z. M. (2021). Visual-spatial skills and mathematics content conceptualisation for pre-service teachers. *Indonesian Journal of Science and Mathematics Education, 4*(3), 223–241. https://doi.org/10.24042/ijsme.v4i3.9842

Munaw, M. B., & Tegegn, M. T. (2022). Visual impairment and psychological distress among adults attending the University of Gondar tertiary eye care and training centre, northwest Ethiopia: A comparative cross-sectional study. *PLOS ONE, 17*(2), e0264113. https://doi.org/10.1371/journal.pone.0264113

Naipal, S., & Rampersad, N. (2018). A review of visual impairment. *African Vision and Eye Health, 77*(1), a393. https://doi.org/10.4102/aveh.v77i1.393

Oguntola, J. I. (2025). *Effect of seeing-AI strategy on the academic achievement of visually impaired junior secondary school students in mathematics* (Unpublished M.Sc. dissertation). Tai Solarin University of Education, Ijagun, Ogun State, Nigeria.

Oyebanji, M. S., & Idiong, U. S. (2021). Challenges of teaching mathematics to students with visual impairment. *Malikussaleh Journal of Mathematics Learning, 4*(1), 1–6. https://doi.org/10.29103/mjml.v4i1.2538

Parvin, S. (2015). Social inclusion of visually impaired students studying in a comprehensive secondary mainstream school in the South of England. *International Journal of Scientific and Research Publications, 5*(2), 1–5. https://www.ijsrp.org/research-paper-0315/ijsrp-p3992.pdf

Pundlik, S., Shivshanker, P., & Luo, G. (2023). Impact of apps as assistive devices for visually impaired people. *Annual Review of Vision Science, 9*(1), 111–130. https://doi.org/10.1146/annurev-vision-111022-123837

Raguindin, P. Z. J., Custodio, Z. U., & Bulusan, F. (2021). Engaging, affirming, nurturing inclusive environment: A grounded theory study in the Philippine context. *IAFOR Journal of Education, 9*(1), 113–131. https://eric.ed.gov/?id=EJ1291741

Samsuddin, A. F., & Retnawati, H. (2018). Mathematical representation: Role, challenges and implications on instruction. *Journal of Physics: Conference Series, 1097*, 012152. https://doi.org/10.1088/1742-6596/1097/1/012152

Saputra, I., Astuti, M., Sayuti, M., & Kusumastuti, D. (2023). Integration of Artificial Intelligence in Education: Opportunities, Challenges, Threats and Obstacles. A Literature Review. *The Indonesian journal of computer science*, *12*(4), 1590–1600. https://doi.org/10.33022/IJCS.V12I4.3266

Shoaib, M., Fitzpatrick, D., & Pitt, I. (2023). Assistive technology-based solutions in learning mathematics for visually impaired people: Exploring issues, challenges and opportunities. *Multimedia Tools and Applications, 82*(29), 46153–46184. https://doi.org/10.1007/s11042-023-17409-z

Sinay, E., & Nahornick, A. (2016). *Teaching and learning mathematics research series I: Effective instructional strategies*. Toronto District School Board. https://www.tdsb.on.ca/Portals/research/docs/reports/Teaching%20and%20Learning%20Math%20Research%20Series%201.pdf

Solomon, O. I., & Oyem-Ifeanyi, M. (2021). Gender differential mathematics achievement of students in selected senior secondary schools in Delta State, Nigeria. *MAN Journal of Mathematics Learning, 46*(1), 58. https://www.researchgate.net/profile/Sabitu-Kamoru-Abiodun/publication/376831416_ABACUSEDU2021/links/658b3bda0bb2c7472b1315f4/ABACUSEDU2021.pdf#page=67

Sule, S. S., & Sunday, Y. (2024). Influence of school type and gender on students' performance in mathematics in Damaturu Education Zone, Yobe State, Nigeria. *Journal of Science, Technology and Mathematics Pedagogy, 2*(1), 52–63. https://jostmp-ksu.com.ng/index.php/jostmp/article/view/126

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257–285. https://doi.org/10.1016/0364-0213(88)90023-7

Sweller, J., Ayres, P., & Kalyuga, S. (2011). Altering element interactivity and intrinsic cognitive load. In *Cognitive Load Theory* (pp. 203–218). Springer. https://doi.org/10.1007/978-1-4419-8126-4_10

Szabo, Z. K., Körtesi, P., Guncaga, J., Szabo, D., & Neag, R. (2020). Examples of problem-solving strategies in mathematics education supporting the sustainability of 21st-century skills. *Sustainability, 12*(23), 10113. https://doi.org/10.3390/su122310113

Tabachnick, B. G., & Fidell, L. S. (2019). *Using multivariate statistics* (7th ed.). Pearson.

Udonsa, A. E. (2015). Gender disparity in mathematics performance among secondary school students in Adamawa State, Nigeria. *Journal of Sociology, Psychology and Anthropology in Practice, 7*(1), 49–56. https://icidr.org.ng/index.php/Jspap/article/view/1643

© 2026 by Author/s

Valderama, J., & Oligo, J. (2021). Learning retention in mathematics over consecutive weeks: Impact of motivated forgetting. *International Journal of Evaluation and Research in Education, 10*(4), 1245–1254. https://doi.org/10.11591/ijere.v10i4.21942

Wang, M. T., & Degol, J. L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. *Educational Psychology Review, 29*, 119–140. https://doi.org/10.1007/s10648-015-9355-x

World Health Organization. (2023). *World report on vision*. https://www.who.int/publications/i/item/world-report-on-vision

Xu, Z. (2024). AI in education: Enhancing learning experiences and student outcomes. *Applied and Computational Engineering, 51*(1), 104–111. https://doi.org/10.54254/2755-2721/51/20241187

Xue, K., & Barker, E. (2022). Using artificial intelligence (AI) to improve math accessibility for students with visual impairments: Technical brief. *NWEA*. https://eric.ed.gov/?id=ED623510

Yadav, S. (2019). Role of mathematics in the development of society. *International Journal of Research and Analytical Reviews, 6*(4), 295–298. https://ssrn.com/abstract=3677993

Yeh, C. Y., Cheng, H. N., Chen, Z. H., Liao, C. C., & Chan, T. W. (2019). Enhancing achievement and interest in mathematics learning through Math-Island. *Research and Practice in Technology Enhanced Learning, 14*, 1–19. https://doi.org/10.1186/s41039-019-0100-9

Zakariya, Y. F., Ibrahim, M. O., & Adisa, L. O. (2016). Impacts of problem-based learning on performance and retention in mathematics among junior secondary school students in Sabon-Gari area of Kaduna State. *International Journal for Innovative Research in Multidisciplinary Field, 2*(9), 42–47. https://www.academia.edu/download/49231604/201609009.pdf

Zaman, B. U. (2023). Transforming education through AI: Benefits, risks, and ethical considerations. *Authorea Preprints, 1*, 1–16. https://www.researchgate.net/publication/374414199

Zhu, W., Xing, W., Lyu, B., Li, C., Zhang, F., & Li, H. (2025, March). Bridging the gender gap: The role of AI-powered math story creation in learning outcomes. In *Proceedings of the 15th International Learning Analytics and Knowledge Conference* (pp. 918–923). https://doi.org/10.1145/3706468.3706539

© 2026 by Author/s