Transforming Mathematics Instruction in the Gambia: The Role of GeoGebra in Improving Teaching and Learning Outcomes

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DOI: https://doi.org/10.47772/IJRISS.2026.1026EDU0307

Received: 09 May 2026; Accepted: 14 May 2026; Published: 09 June 2026

ABSTRACT

This paper researches how digital technologies, especially GeoGebra in The Gambia, can transform the teaching and learning processes of mathematics. The study synthesizes the evidence related to the topic of GeoGebra use in mathematics education to determine the effectiveness of GeoGebra in addressing persistent issues in mathematics education, including abstract conceptualization, limited interaction with students, and teacher-centered teaching practices.

The results indicate that GeoGebra enhances conceptual learning of students significantly due to the dynamism and the interactive learning environment that GeoGebra provides to students and encourages them to explore and engage in the learning process. It also helps in development of higher-order thinking skills that includes problem-solving, logical reasoning, and critical thinking, which leads to better academic performance. Moreover, its incorporation supports a pedagogical transition between the conventional lecture-based teaching and inquiry-based and student-centred learning methods. Nevertheless, the research observes that there are a number of obstacles to successful implementation, especially in resource-constrained settings such as The Gambia. These are poor technological infrastructure, low access to online materials and inadequate training of teachers. The research concludes that although GeoGebra has a great potential to transform the way mathematics is taught, it cannot be successfully implemented without context-sensitive approaches, long-term investments in educational infrastructure, and ongoing professional development of teachers.

Keywords: GeoGebra; mathematics teaching, conceptual understanding, student interaction, The Gambia

INTRODUCTION

Enhancing the quality of mathematics education remains a critical priority in many developing nations, including The Gambia. Despite the ongoing process of reforming education in The Gambia to make more focus on competency based learning and critical thinking, the teaching of mathematics is still teacher-centred (Treve, 2024). Lecture and book lecture teaching are still used in class, and students' learning is more passive, which hinders the active learning of mathematical knowledge. In the classroom, the teaching and learning style is still mainly based on lectures, and the students' learning is more passive, which limits the students' active learning in the classroom. As a result, many students have weak understanding of concepts which leads to poor academic performance and poor interest in mathematics (citations needed).

In the last ten years, digital technologies have become widely recognized as a way of tackling these challenges that have persisted over the last ten years (Haleem et al., 2022). These tools can change the traditional teaching practices through encouraging interactive and student-centred learning. In particular, GeoGebra has become a powerful and useful tool in mathematics education, allowing users to dynamically visualise abstract concepts, such as functions, graphs, and geometric relationships (Abdulla, 2021; Dahal et al., 2022). GeoGebra allows the manipulation of variables in real-time and in interactive mathematical representation, which supports exploratory and inquiry-based learning and thus conceptual learning and meaningful learning experiences (Mulyani, 2025).

In spite of these benefits, the use of digital technologies and their integration in The Gambia are still in their infancy. A variety of challenges hinders the effective implementation of the technology and includes, but is not limited to, inadequate technological infrastructure, unreliable electricity supply, and limited access to digital devices (Oyetade et al., 2020). Where the technological resources are at hand, limited teacher training and lack of knowledge on how to integrate technology into pedagogy limits the effective use (Shamsudinova et al., 2025).

The high number of students in the classes and the shortage of teaching materials further contribute to the impossibility to implement interactive teaching methods, which supports the practises of teacher-centred and reinforces the lack of opportunities to engage in interaction and critical thinking (Arsenijević et al., 2020).Thus, there is an urgent necessity of the innovative, context-sensitive approaches, which are able to transform the way mathematics is taught in The Gambia.

In this context, GeoGebra has great potential to transform teaching.

In this context, GeoGebra has great potential to transform teaching. Nevertheless, to be successful in the context of integrating technologies, it is not only access to technology but also effective pedagogical practices, the readiness of teachers, and the adaptation of the context (Shamsudinova et al., 2025). This research therefore seeks to determine how GeoGebra can positively impact teaching and learning outcomes as well as identify the challenges and strategies involved in implementing GeoGebra in resource constrained educational contexts.

Research Gap

Although the literature on the integration of digital technology in mathematics education is on the rise, there is still a lack of existing scholarship on how digital technology is implemented in mathematics education in a specific context, especially in a developing country. Much of the current research has been undertaken in technologically rich educational settings where access to digital materials, reliable infrastructure and well-trained educators is readily accessible. The results of these studies therefore are not necessarily transferable to low-resource settings like The Gambia, where implementation barriers such as infrastructure may impact implementation outcomes even more (Ehlert et al., 2025).

Much of the existing literature too is geared towards quantitative and experimental models that mainly aim at quantifying student academic performance. Although such studies help to understand the outcomes of learning, they are more likely to neglect the bigger pedagogical and contextual aspects that shape the successful incorporation of digital technologies into actual classroom settings (Nagy, 2024). Consequently, there is limited knowledge about how tools, like GeoGebra, can be meaningfully adapted to different learning environments.

Moreover, the part of digital technologies in leading the instructional change is underresearched, especially in those settings where the traditional, teacher-centred practices are still predominant. The majority of the literature that exists points out the advantages of GeoGebra without critically questioning the practical challenges of implementation, including infrastructural limitations, large classes, and teacher willingness.

It is worth noting that no studies specifically devoted to The Gambia could be found in the literature. This lack of contextsensitive studies restrains the capacity of educators and policymakers in making informed decisions as far as the integration of digital tools in mathematics education is concerned. The current paper fills these gaps by providing a systematic, contextually based analysis of the GeoGebra integration, both in its pedagogical opportunities and its problems of implementation.

Research Objectives

The main purpose of the study is to discuss how GeoGebra can revolutionize the process of teaching and learning mathematics in The Gambia and improve the outcomes of teaching and learning, through a systematic review of the available literature. To achieve this goal, the objectives of the study are as follows:

1. This study aims to explore how far GeoGebra can enhance students' concept of mathematics.
2. To determine what impact GeoGebra has on student engagement and the general learning experience.
3. To establish the issues that hinder successful application of GeoGebra in mathematics classrooms in The Gambia.
4. To investigate context-sensitive approaches to the effective and efficient use of GeoGebra in educational environments that are resource-constrained.

Research Questions

This study has the following research questions that will guide this study:

1. What is the effect of GeoGebra on students' conceptual understanding of mathematics?
2. What is the impact of GeoGebra on student engagement and learning experience?
3. What are the barriers to the implementation of GeoGebra in The Gambia?
4. What strategies can help effectively and sustainably implement GeoGebra in resource-constrained environments?

LITERATURE REVIEW

The introduction of digital technology into mathematics education has widely been accepted as a transformational force that has the potential to not only enhance teaching practice, but also the learning outcomes of students. Studies show that learning environments that are enhanced by technology facilitate active learning among students and promote a deeper conceptual understanding than traditional methods of instruction (Yuan et al., 2023). These environments facilitate student centred learning by way of exploration, interaction and collaboration thus providing the learner with a critical thinking and problem solving ability. This change is especially consequential in terms of the way the deeply rooted issues of mathematics teaching in developing settings can be solved (Laal & Mohammad, 2021).

GeoGebra has proven to be an effective educational tool by making it possible to combine various mathematical representations in a single interactive technology. It enables learners to operate at the same time with algebraic, graphical and numerical expressions, thus, conceptually bridging between abstract and concrete mathematical concepts (Yerizon, 2023). Their multi-representational capacity enhances the capability of the students to interpret and analyse the relationships in mathematics to gain a more holistic view of mathematical structures. These features render GeoGebra especially efficient in facilitating the conceptual learning in a variety of classroom environments (Rexigel et al., 2024).

The theoretical basis of the effectiveness of GeoGebra is based on the constructivist theory of learning which stipulates that learning takes place through active exploration, interaction, and reflection by the learner. GeoGebra helps to facilitate this process because it allows students to manipulate variables and see how mathematical representations can change in real-time (Abdulla, 2021; Moreno et al., 2024). Such interactive processes encourage higher order of thinking and more valued learning that improves the chances of students attaining conceptual knowledge as opposed to learning procedures by heart.

The Technological Pedagogical Content Knowledge (TPACK) framework can also be used to understand the GeoGebra integration. This framework provides emphasis on the significance of using technological, pedagogical and content knowledge in an effective teaching practice. GeoGebra is an application that can help connect these areas by allowing educators to create useful and interactive learning experiences. Nevertheless, how effective integration is will be determined by the ability of teachers to tap into these correlated bodies of knowledge. It is the preparedness of the teacher that therefore comes out as a critical determinant of the effect of the technology on the learning outcome.

Empirical studies continuously substantiate the argument that GeoGebra augments the conceptual knowledge that students have about mathematics. The research indicates that there are considerable improvements in geometry, algebra, and calculus with the use of dynamic visualisation tools (Latifi, 2021). These profits can be mostly explained by the ability of the software to make the abstract ideas more approachable and interesting. It has also been demonstrated that GeoGebra has the ability to develop higher-order thinking skills, such as mathematical reasoning and problem-solving, which can contribute to better educational outcomes overall.

GeoGebra has also been shown to have a positive impact on student engagement and motivation in mathematics classrooms. Learning environments that are interactive and visually rich facilitate students to engage actively in lessons, and the increased engagement is directly linked to improved learning outcomes (Živković et al., 2023). Active participation also instils in students confidence in their mathematical skills, a further argument in favour of technology integration in teaching and learning.

Even with these advantages, there are a number of challenges that hinder the effective application of GeoGebra in schools. The lack of proper technological infrastructure is one of the key obstacles, specifically in the developing countries (Awaji, 2025). The lack of teacher training also narrows the prospects of using technology effectively in the classroom (Mulyani, 2025). These issues underscore the need to have solid support systems in place to ensure that the conditions that are needed to make the integration process effective are in place, especially in a context such as The Gambia where infrastructural constraints are acute.

Another weakness of the literature is that it tends to generalise results to various educational context. Most studies are done within well-resource settings where access to technology and professional growth of teachers are easily accessible. The conditions in such settings are vastly different as in resource-constrained settings such as The Gambia, which makes the broad applicability of existing results questionable. This highlights the need to have contextually based research which considers the local realities.

Overall, the literature confirms that GeoGebra has a great potential to change the way mathematics is taught and achieved the success in the learning process. Nonetheless, its success depends on the correspondence of the technological resources, pedagogical strategies, and situational factors. The full advantages of GeoGebra cannot be realised without access to technology, but a good instructional strategy and prepared teachers. These considerations are particularly relevant in the context of resource scarcity, and point to the necessity of a holistic, context-sensitive approach in terms of GeoGebra integration in The Gambia.

METHODOLOGY

This research paper follows a Systematic Literature Review (SLR) research methodology to explore the role of GeoGebra in changing mathematics teaching and improving teaching and learning outcomes with specific reference to The Gambia. The SLR approach is a systematic, transparent and reproducible method of synthesising existing research by enabling the identification, appraisal and integration of findings of multiple studies (Tingelhoff et al., 2025). To achieve methodological rigour and transparency, the research followed the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021).

Search Strategy

Two large academic databases Google Scholar and Scopus were searched systematically to locate pertinent literature. To ensure a wide scope of studies regarding GeoGebra and mathematics education in a wide variety of education settings, the search strategy was tailored in such a way. The search terms were: GeoGebra, mathematics education, conceptual understanding, student engagement, learning outcomes, and technology integration.

The search was limited to publications of the last years, 2020-2025, which reflects the timeframe of the most recent developments in the use of digital technologies in mathematics education. Preference was given to those works that have been done in developing and resource-constrained settings to make sure they are relevant to The Gambia.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI June 2026 | Special Issue on Education

Study Selection Process

The four-stage PRISMA model was used in the process of selecting the studies: identification, screening, eligibility assessment, and inclusion. A preliminary search of the two databases gave a result of 89 records. After the elimination of duplicates and records which were not considered as relevant after their screening on the basis of their title and abstract. 48 studies were left to be reviewed as full-text articles. Following the application of the inclusion and exclusion criteria at the full-text stage, a total of 38 peer-reviewed articles were incorporated into the final thematic synthesis. The PRISMA flow diagram of this process is shown in figure 1.

Figure 1. PRISMA Flow Diagram of Study Selection Process

(n = total records identified through database searching = 89)

IDENTIFICATION
Records identified through database searching (Google Scholar and Scopus; n=89)
↓
SCREENING
Records screened by title and abstract (n = 89) Records excluded (duplicates, off-topic): n = 41 Records remaining: n = 48
↓
ELIGIBILITY
Full-text articles assessed for eligibility (n = 48) Full-text articles excluded (no methodological clarity, not related to mathematics education): n = 10
↓
INCLUDED
Studies included in thematic synthesis (n = 38)

Inclusion and Exclusion Criteria.

Well defined inclusion and exclusion criteria were formulated to assure the relevance and methodological rigour of the review. Peer-reviewed journal articles or conference papers on GeoGebra or other similar dynamic mathematics programs were considered as studies. Preference was given to research that studied conceptual understanding, student engagement or instructional outcomes, and research that was conducted in developing or resource constrained educational background. Included in the studies were those which were non-academic, did not have methodological clarity, or were not related to mathematics education.

Data Analysis

The thematic analysis method was applied to examine the chosen studies and reveal common patterns and important discoveries throughout the literature. This approach allowed coding and categorisation of results of various studies in a systematic manner. The analysis resulted in five major themes, namely conceptual understanding, student engagement, instructional transformation, implementation challenges, and context-sensitive strategies. Thematic synthesis allowed integrating these findings into coherent units of analysis and offered a systematic understanding of the impact of GeoGebra on mathematics teaching and learning outcomes (Abdella, 2025).

Contextual Interpretation

The analysis of the results was based on the concrete educational background of The Gambia. Contextual variables such as poor technological infrastructure, high number of students in a classroom, and different degrees of teacher readiness were put into consideration during the analytical process. This was necessary to make sure that the literature synthesis was based on real educational circumstances not on assumptions that were based on more well-equipped settings. The contextual lens increased the practical applicability of the findings and recommendations made in the study and made it easier to have a more significant assessment of the adaptability of GeoGebra to resource-constrained environments (Unesco, 2020).

Methodological Rigour

This study is rigorous, transparent, and replicable, which was ensured by the application of a systematic literature review methodology, based on PRISMA protocols (Wang et al., 2022). The structured search strategy and clearly defined selection process minimised the selection bias, whereas explicit inclusion and exclusion criteria enhanced consistency and dependability in study selection. These measures enhance the validity and credibility of the findings in the context of The Gambia and beyond.

FINDINGS AND DISCUSSION

The thematic analysis of the 38 included studies revealed five main themes: conceptual understanding, student engagement and learning outcomes, pedagogical shift and instructional transformation, implementation challenges, and context-sensitive implementation strategies. Table 1 gives a thematic summary of the major works that inform these themes, and then discusses each in detail.

Table 1. Thematic Synthesis of Key GeoGebra Studies (2020-2025)

No.	Authors	Year	Theme	Key Findings
1	Abdulla	2021	Conceptual Understanding	GeoGebra enhances conceptual learning through dynamic visualisation and real-time interaction with mathematical concepts.
2	Haleem et al.	2022	Technology Integration	Digital tools promote interactive, student-centred learning environments and improve instructional delivery.
3	Živković et al.	2023	Student Engagement	Interactive learning environments enhance student motivation and positive attitudes toward mathematics, supporting improved engagement and outcomes.
4	Moreno et al.	2024	Constructivist Learning	Supports active knowledge construction through exploration, manipulation, and inquiry-based learning.
5	Mulyani	2025	Pedagogical Integration (TPACK)	Effective GeoGebra use depends on teachers' ability to integrate technology, pedagogy, and content knowledge.

GeoGebra and Conceptual Understanding

The reviewed literature also consistently shows that the use of GeoGebra has a significant impact in improving students' concept understanding of mathematics through dynamic interaction with the mathematical representations (Abdulla, 2021; Latifi, 2021). It is also able to integrate symbolic, graphical and numerical representations at the same time which enhances the cognitive processing and also helps to make meaningful connections between the abstract mathematical concepts (Yerizon, 2023). It is consistent with constructivist learning theory which focuses on active knowledge construction by exploring, manipulating and reflecting (Moreno et al., 2024).

These benefits are not necessarily to be taken for granted when implementing technology, however. As a result, the effectiveness of GeoGebra is highly dependent on how it is made purposeful in classroom practices and the pedagogical skill of teachers using it (Mulyani, 2025). The software in some contexts might be used as an illustration of learning rather than a vehicle for conceptual learning (Ziatdinov, 2022).

This is a big challenge in the Gambian education sector where mathematics teaching has been mostly teacher-led (Treve, 2024). The transformation from being a recipient of information to an active constructor of understanding of mathematics is indeed what GeoGebra can achieve, but this will need pedagogical adaptations

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI June 2026 | Special Issue on Education

and institutional support to achieve. In technologically constrained Gambia classrooms, the conceptual benefits that have been described in international studies might not be easily realised if classroom practices are not deliberately restructured (Oyetade et al., 2020; Shamsudinova et al., 2025)

Student Engagement and Learning Outcomes

The findings from these reviewed studies indicate that GeoGebra is a tool that has a positive impact on enhancing student engagement in learning, as it provides interactive learning space and visualization to make students feel passionate about learning (Haleem et al., 2022; Živković et al., 2023). Manipulating mathematical objects in real-time enhances active engagement and instant feedback, which have been linked to higher engagement and retention in learning ((Dahal et al., 2022).

However, the more engaged a student is, the more that isn't necessarily correlated with better grades. Engagement can be considered to be meaningful when integrated in the instructional process that is well organized into instructional activities that support reasoning, problem solving, and conceptual reflection (Mulyani, 2025). When pedagogical goals are not effectively connected to the ways the space is being used in the classroom, technology-rich environments can lead to superficial interactions (Moreno et al., 2024).

In the context of The Gambia, some practical constraints may hinder students' engagement with GeoGebra during instruction, such as the high number of students in a class, the lack of access to devices, and a limited amount of time spent teaching it (Awaji, 2025; Oyetade et al., 2020). Based on these contextual factors, the value of GeoGebra for education is not only the availability of software but also an adaptive classroom management strategy and also a local context-sensitive instructional design.

Pedagogical Change and Instructional Transformation

The introduction of GeoGebra is not just about technology; it also creates opportunities for a more comprehensive pedagogical transformation from teacher-centred approaches to student-centred inquiry-based learning (Haleem et al., 2022). GeoGebra can be used to implement educational strategies that motivate students to create their own mathematical knowledge following constructivist learning principles (Moreno et al., 2024), as it allows for experimentation, visualization, and collaborative exploration.

But it's not simply a matter of digital tools leading to instructional transformation. In order to make meaningful pedagogical changes, teachers must be ready, both technically and pedagogically, to design pedagogical experiences that involve inquiry learning (Mulyani, 2025). This dual preparedness is crucial, or else GeoGebra may be used simply to replicate traditional teacher-led demonstrations in a digital format, instead of facilitating authentic teacher-led innovation (Ziatdinov, 2022).

This challenge is very pronounced in the Gambian educational system where teacher-centred teaching approaches still hold sway (Treve, 2024). Successful transformation is therefore based on the continuous professional development and institutional support, not on the one-off implementation of software, but rather on gradual pedagogical adaptation (Shamsudinova et al., 2025).

Implementation Challenges

Among the reviewed evidence, infrastructural and pedagogical barriers have been found to be the most crucial barriers to implementing GeoGebra (Oyetade et al., 2020). In many developing educational systems, limited access and limited availability of computers, unstable electricity supply, inadequate internet connectivity and insufficient technical maintenance prevent sustained technology integration in the education system structure.

Teacher-related problems are also important. According to Mulyani (2025), the TPACK model focuses on the convergence of technology knowledge, pedagogical skills, and mathematical content knowledge, highlighting the importance of integrating technologies into teaching. (Auza et al. (2025), stated that the TPACK framework emphasized the convergence of the three elements of technological knowledge, pedagogical skills, and mathematical content knowledge, indicating that the integration of technologies in teaching is important. If teachers are not confident and well-prepared, the use of GeoGebra may not be optimal or it might be used in ways that are not conducive to meaningful student learning (Abdella, 2025).

These difficulties are not just logistical, but systemic in the context of education within The Gambia. There may be a lack of investment in digital infrastructure and a lack of institutional support that may hinder the capacity to implement it in sustainable instructional reform (Unesco, 2020). This implies that it is necessary to act in a coordinated manner in order to achieve the successful implementation of GeoGebra, both structurally and pedagogically.

Context-Sensitive Implementation Strategies

In the literature reviewed, it was suggested that successful GeoGebra implementation should be based on the context in which it is applied, in order not to simply copy models developed at different contexts with more advanced technology (Siregar, 2025).

Professional development for teachers needs to be the cornerstone of implementation for The Gambia. These training programs should go beyond mere operation of software, encompassing lesson design, inquiry-based pedagogy, and classroom management in technology-supported learning environments (Shamsudinova et al., 2025).

Making infrastructure accessible should consider practical access. Considering the technological limitations, the offline version of GeoGebra can be seen as a viable way to implement in schools that are not connected to the Internet (Awaji, 2025).

A staged rollout strategy starting with pilot programs in targeted secondary schools would enable context-specific adaptations, incremental improvement, and evidence-based scaling up. This gradual approach is more sustainable than the instantaneous rollout, and will enhance the possibility of meaningful instructional transformation (Oyetade et al., 2020; Unesco, 2020).

Proposed Framework for GeoGebra Integration in Gambian Schools

The implementation of GeoGebra in the mathematics instruction of Gambian schools must be a structured and phased process that is context-sensitive. Considering the infrastructural and pedagogical context of Gambian education, the implementation should be gradual through institutional support, teacher training, and constant monitoring.

Phase 1: Teacher Professional Development

Teacher preparedness is the key to successful implementation. Systematic professional development for teachers in mathematics should be provided in the use of GeoGebra, design of lessons with interaction and use of inquiry in teaching. Pedagogical application in the classroom should be stressed in training programmes as well as technical competence to ensure effective classroom integration.

Phase 2: Infrastructure Readiness

Schools should define the minimal technological requirements to be met in the classroom when using GeoGebra effectively: stable access to the Internet, computers, projectors or a system for displaying the GeoGebra files, stable electricity. If the Internet is not always available, the schools should define the minimal technological requirements to be met when using GeoGebra effectively (computers, projectors or a system for displaying the GeoGebra files, the stability of the electricity supply).

Phase 3: Pilot Classroom Implementation

Pilot programmes in selected schools, especially for instructional topics like geometry, algebra, coordinate systems, and graph transformations should be implemented as an initial step. Pilot implementation would provide for adaptation and refinement of instructional strategies.

Phase 4: Monitoring and Evaluation

The effectiveness of implementation needs to be monitored with measurable indicators including student engagement, conceptual understanding outcomes, teacher feedback, mathematics achievement performance, classroom observations and more.

Phase 5: National Scale-Up

The pilot programmes should be used to inform wider curriculum integration, through collaboration between the Ministry of Basic and Secondary Education, teacher education institutions, school management and education and curriculum specialists. National expansion must be based on evidence-based evaluation to address sustainability, contextual appropriateness.

Cross-Thematic Synthesis

The combination of the five themes provides a consistent and mutually supportive image of the way GeoGebra can be used in mathematics education. Abdulla (2021), shows how the active engagement with mathematical representations enhances the level of conceptual understanding and minimises the need to rely on rote memorisation. Haleem et al. (2022), demonstrate that technology-enhanced instruction promotes active learning and helps to shift the learning environment toward student-centred learning. It was also discovered that interactive visualisation tools are related to better student motivation and more positive attitude towards mathematics, the latter directly linked to better outcomes (Živković et al., 2023).

On the theoretical level, Moreno et al. (2024), confirm that the design of GeoGebra is quite consistent with the principles of constructivist pedagogy that allows learners to actively construct the knowledge by means of exploration and inquiry. This paper goes on to show that the actualisation of these benefits is crucially dependent on teacher preparedness: without integrated technological, pedagogical, and content knowledge - as theorised in the TPACK model - the tool runs a risk of being used merely in a superficial way, rather than in a transformatively way. The combination of this evidence is that GeoGebra is a tool that would help bring about instructional change, but that is contingent on readiness in the context, continuous professional growth, and long-term investment in infrastructure.

CONCLUSION

In this study, the researchers explored the possibility of GeoGebra's potential role in transforming mathematics education in The Gambia and enhancing mathematics teaching and learning based on interactive exploration, dynamic visualization and student centredness. The reviewed evidence suggests that GeoGebra has significant potential to contribute to students' conceptual understanding, to foster higher order thinking skills like mathematical reasoning and problem-solving, and to enable a pedagogical change from teacher-centred instructional practices to more interactive and inquiry-based learning environments. The results show that digital technology can be a powerful enabler in solving some of the entrenched issues in mathematics education.

But the implementation of GeoGebra is very much influenced by the contextual factors. Some major challenges to effective adoption are still the lack of technological infrastructure, access to digital resources and preparedness of teachers, especially in resource-limited learning contexts like The Gambia. The challenges highlight the need for an overall and contextually-aware approach to achieving successful implementation, rather than relying on technology for technology's sake.

This study adds to the existing literature on the subject, and reveals the context-specific analysis of the implementation of GeoGebra in Gambian schools, which has been ignored in most scholarly works. Its findings are grounded in the theoretical perspectives of CLT and the TPACK model, yet connect to the practical context of the classroom within the school system and could therefore be applicable to other educational systems with similar infrastructural and pedagogical issues.

Limitations of the Study

The study has limitations as its secondary data was obtained by synthesizing it in the form of a systematic literature review methodology. This process offers a systematic and explicit way to draw together the current body of knowledge on the topic but lacks primary empirical data (for example, classroom observations, teacher interviews, and student performance measurement) from Gambian schools.

Therefore, the findings were not able to be interpreted as empirical data in real classrooms. Despite the available vast amount of literature on the use of GeoGebra in mathematics education, contextual differences in infrastructure, teacher readiness and institutional support can be seen to affect implementation outcomes differently in Gambian schools.

Practical Implications

The findings indicate that it is important for the policy makers, school leaders and mathematics teachers to focus their investment strategies on teacher training and technological technology to ensure effective integration of GeoGebra. In order to ensure that teachers have technical expertise and pedagogic confidence to implement the courses in class, continuous training courses are necessary. Different teaching styles, such as blended learning and the use of various technologies, could also help to improve the successful use of digital resources in different learning environments. Various teaching styles, including blended learning and the use of technology, could also be used to help improve the successful use of digital resources in different learning environments.

Future Research Directions

The present study recommends that the review be continued in the future by empirical investigations in the classroom environment in Gambia schools. Studies of this kind could involve interviews with teachers, classroom observations, analyses of students' performances, etc., to assess the real effectiveness of the use of GeoGebra. Longitudinal studies also would be useful in studying the long-term sustainability of instructional transformation. Finally, comparative analyses of the different resource-poor educational settings might produce models that could be transferred to other settings. Finally, for the successful implementation of GeoGebra in the Gambia's mathematics education, evidence-based plans, ongoing institutional support and context sensitive implementation strategies are needed. With proper support, GeoGebra can make a significant impact on the mathematics education in The Gambia and other regions.

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