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Teaching Trigonometry in Alfred Nzo West Education District: Educator Perspective and Challenges

Kereditse Gladys Chake[1], Thabane Willie[2] & Phage Itumeleng[3]

ABSTRACT

This qualitative case study investigates challenges faced by educators teaching trigonometry in Grade 12 within the Alfred Nzo West Education District, where persistent underperformance is linked to socio-economic and resource limitations. Using a constructivist paradigm, six educators from diverse backgrounds participated in semi-structured interviews. Key issues include reliance on traditional, less engaging methods, limited use of technology, and insufficient, sporadic professional development. Findings suggest that while traditional approaches provide structure, they often fail to foster deep student engagement, whereas technology, when accessible, enhances understanding. Professional development lacks specificity to address the unique challenges of trigonometry pedagogy. The study concludes by recommending increased teacher training, improved resource distribution, and greater technology integration to support teaching effectiveness. These changes could help address educational inequalities in the district, promoting better academic outcomes and learner advancement in trigonometry.

Keywords: Teaching strategies; trigonometry; constructivist paradigm; professional development; technology integration.

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[1] ***Corresponding Author***, Department of Prostgraduate Studies, Central University of Technology, Free State, Bloemfontein, South Africa, E-mail: kereditseleeuw@gmail.com.
[2] Department of Education and Professional Studies, Central University of Technology, Free State, Bloemfontein, South Africa, E-mail: rthabane@cut.ac.za.
[3] Department of Mathematics, Science and Technolgy Education, Central University of Technology, Free State, Bloemfontein, South Africa, ORCID: 0000-0001-8611-1999, E-mail: iphage@cut.ac.za

INTRODUCTION AND BACKGROUND

Trigonometry, a cornerstone of mathematical fluency with applications across physical and engineering sciences, has received significant research attention in recent years (Thompson, 2016). However, studies highlight the particular challenges associated with effective trigonometry instruction, especially in high-stakes Grade 12 years (Foley et al., 2017). This study focuses on the Alfred Nzo West Education District (ANWED) in South Africa, where learners have consistently underperformed in trigonometry concepts. The research investigates effective teaching approaches to improve the trigonometry achievement of Grade 12 learners within this specific context.

The increasing pervasiveness of digitalization necessitates the exploration of its potential impact on students' academic and professional trajectories, further emphasizing the importance of this research (Sturman, Burge, Cook, and Weaving, 2018).

The disruptive influence of the COVID-19 pandemic on traditional pedagogical approaches underscores the need for innovative educational methods (Shawe, 2020). Shawe's (2020) findings suggest that technology integration may be a viable solution to address learning deficits arising from the pandemic. Aligned with this notion, Mafugu (2020) highlights the disparities in resource allocation and their consequences on learner achievement, advocating for more equitable distribution of educational resources.

Ndlovu's (2019) work emphasizes the imperative of teacher training in enhancing mathematics instruction, implying that continuous professional development is vital for adapting to evolving educational challenges. Furthermore, Nhase (2019) points to the importance of culturally relevant pedagogy in fostering knowledge acquisition and engagement. Mofokeng (2018) advocates for community-based interventions to support learning, citing specific challenges faced by Grade 12 learners in Kestel, including language barriers and lack of parental support.

While these studies offer valuable insights on mathematics education, they do not explicitly address the particular challenges associated with trigonometry instruction within the socioeconomic and financial constraints exacerbated by the COVID-19 pandemic. This study aims to bridge this gap by investigating the specific challenges experienced by teachers in the ANWED and proposing the use of indigenous games as a strategy to enhance trigonometry teaching. The overall objective is to provide a comprehensive analysis of these challenges along with feasible solutions to improve the academic performance of Grade 12 learners in the district.

The structure of the work follows a logical progression. The initial section establishes the theoretical framework, followed by a detailed methodology section that outlines the data collection techniques and study design. The findings of the investigation are presented subsequently, and the report concludes with a discussion of the implications of the results, along with recommendations for further research and practical application.

Problem Statement

Grade 12 students in the Alfred Nzo West Education District's low performance in trigonometry highlights the difficulties in teaching and learning. Examining National Senior Certificate (NSC) Mathematics Performance data, particularly for the Eastern Cape Province over the past three years, reveals a concerning underachievement trend. Performance rates in the Alfred Nzo West Education District consistently fall below those of districts like Buffalo City, Nelson Mandela Metro, and Sarah Baartman, where pass rates approach 50% (Department of Basic Education, South Africa, 2022).

Particularly in the socioeconomic context of the Alfred Nzo West Education District, existing studies on general mathematics teaching methodologies may not adequately address the unique challenges associated with trigonometry education. This study aims to bridge this gap by identifying and exploring successful teaching strategies specifically tailored to the particular difficulties faced by both teachers and students in this district.

These poor performance results extend beyond the realm of immediate academic success, potentially influencing students' overall mathematical motivation and interest. This can have a cascading effect on their future career paths, particularly in Science, Technology, Engineering, Arts, and Mathematics (STEAM) disciplines that require a strong foundation in

mathematics (Watt, Hyde, Petersen, Morris, Rozek, and Harackiewicz, 2017). Thus, this study addresses both the long-term goal of enhancing students' educational and professional opportunities and the immediate need to improve trigonometry performance. It specifically seeks to answer the research question: *What challenges do educators face in implementing teaching strategies for trigonometry in the Alfred Nzo West Education District?*

THEORETICAL FRAMEWORK

Decoloniality Theory

Decoloniality theory, as articulated by scholars like Mukavetz (2018) and McEwan (2018), emerged in critique of expanding global capitalism and its homogenizing influence on cultures. It centers on dismantling the power structures of colonialism that perpetuate social, economic, and epistemic inequalities (Mikavetz, 2018). Decoloniality calls for a critical examination of knowledge production, foregrounding previously marginalized and indigenous perspectives that have been historically silenced (Tuck and Yang, 2012). This framework challenges the privileging of Western knowledge systems, advocating for the exploration and integration of diverse ways of knowing.

The relevance of decoloniality to this study lies in its emphasis on contextually responsive pedagogy. As Mafile'o, Kokinai, and Redman-MacLaren (2022) suggest, decolonial approaches urge educators to consider the social and economic realities of their students. By employing a decolonial lens, this study aims to identify culturally relevant and effective teaching practices that can address the specific challenges faced by mathematics educators in the Alfred Nzo West Education District.

Relevance to the Study

Combining indigenous knowledge systems with culturally sensitive teaching strategies might transform education by decoloniality. This idea questions Western teaching strategies, which might not apply in the Alfred Nzo West Education District because cultural and socioeconomic factors affect learning results (Le Grange, 2016). Willis (2023) supports the idea that understanding of how teachers bridge cultural difference in teacher-student relationship can provide insight into the cultural, social and emotional capabilities needed in teaching. Decoloniality supports pedagogies including the lived experiences of students, therefore increasing the inclusive and successful nature of education.

Decoloniality is used in this work to offer culturally relevant trigonometry teaching approaches. For students, indigenous games and local examples can help trigonometry to be more fun and accessible Chikoko (2016). Teaching trigonometry in a way that fits with students' cultural background may help them learn more, remember things better, and do better in school.

Decolonization deals with societal problems in the Alfred Nzo West Education District that make it hard to learn. Socioeconomic imbalance limits the resources that schools can use, which makes students do poorly (Karimah, 2020). This study suggests decolonial structure changes like community-based support networks and resource sharing to help fix these problems Heleta (2016).

Contribution to the Proposed Solution

***Culturally Responsive Teaching*:** Research suggests that incorporating culturally responsive teaching strategies can improve student engagement and achievement in mathematics across diverse populations. This could involve leveraging local contexts and knowledge systems to make trigonometry concepts more relatable for students in the Alfred Nzo West Education District.

Mukavetz's (2018) emphasis on collaborative knowledge construction remains valuable.

***Student-Centered Learning*:** Studies have shown that student-centered approaches encouraging active participation can improve mathematics learning outcomes.

By combining these approaches, teachers in the Alfred Nzo West Education District can create a more inclusive and effective learning environment for trigonometry.

LITERATURE REVIEW

History of the Curriculum in Mathematics Education

Many educational ideologies and sociopolitical contexts have shaped the development of the mathematics curriculum. Historically, a pendulum swing has existed between traditional

approaches emphasizing rote memorization and procedural fluency, and progressive methods prioritizing conceptual understanding and problem-solving (Kholid et al., 2021). For instance, the mid-20th century saw the rise of the "New Math" movement, driven by the urgency to compete in the global technological landscape (Simon, 2020). While its goal of introducing abstract concepts earlier was commendable, it was criticized for being overly abstract for students and ultimately led to a return to more conventional methods (Pepin et al., 2017).

In the case of South Africa, the apartheid era's rigid and Eurocentric curriculum marginalized indigenous knowledge systems and restricted access to quality mathematics education for the majority (Khoza and Biyela, 2020). In order to fix these problems, changes made after apartheid tried to push for a curriculum that included a lot of different cultural points of view and emphasised critical thinking (Inglis and Foster, 2018). However, implementation challenges persist due to inadequate teacher training and resource constraints (Naidoo, 2021). The current South African curriculum, which is spelt out in the Curriculum and Assessment Policy Statement (CAPS), tries to teach both basic skills and higher-order thinking (Gustafsson and Nonkenge, 2025). CAPS stresses how important it is to be able to think about ideas, solve problems, and use maths in real-life situations. Despite these laudable goals, ongoing socioeconomic inequalities and uneven teacher preparedness continue to hinder the curriculum's effectiveness (Karimah,2020).

Professional Learning Communities (PLCs) in Mathematics Education

Professional Learning Communities (PLCs) have emerged as a promising strategy to enhance teacher effectiveness and student achievement Voelkel et al. (2017). Through collaborative efforts like shared best practices, group projects, and analysis of teaching methods, teachers within PLCs leverage these networks to strengthen their pedagogical skills and subject-matter knowledge in mathematics (Burns, Naughton, Preast, Wang, Gordon, Robb, and Smith, 2018). These communities foster the dissemination of innovative instructional approaches, including technology integration and inquiry-based learning, within the classroom (Hairon et al., 2017). Notably, Voelkel et al. (2017) found that PLC participation correlated with improved student performance in mathematics and enhanced teacher practice.

However, successful PLC implementation requires specific conditions, such as administrative support, a culture of trust among educators, and dedicated time for collaboration (Burns et al., 2018). These requirements may pose challenges for deployment in resource-constrained settings like the Alfred Nzo West Education District (Brodie, 2021). Despite these potential limitations, the collaborative and focused learning environment fostered by PLCs could hold promise for improving trigonometry learning in the district.

Conceptualization and Use of PLCs to Enhance Trigonometry Teaching

Understanding the specific educational context of the Alfred Nzo West Education District is crucial to enhancing trigonometry instruction through Professional Learning Communities (PLCs). Research suggests that trigonometry's inherent abstractness and spatial reasoning components challenge teachers and pupils Chirumamilla et al. (2020). Effective trigonometry instruction not only requires content knowledge but also the pedagogical skills to effectively translate these abstract concepts into real-world applications that resonate with students' experiences (Lupahla, 2020).

Challenges in Implementing PLCs in Resource-Constrained Settings

PLCs hold promise for enhancing mathematics instruction, yet their implementation faces significant challenges in under-resourced districts like Alfred Nzo West. Hairon et al. (2017) identify time and financial constraints as critical impediments to consistent collaboration. Teachers in such schools often contend with heavy workloads and limited access to professional development opportunities. Furthermore, Dogan (2018) underscores the necessity of strong leadership and a supportive school culture for the effective functioning of PLCs.

The Role of Technology in Enhancing PLCs and Trigonometry Teaching

The strategic integration of technology can be a critical factor in enhancing both trigonometry instruction and Professional Learning

Community (PLC) performance. Even in geographically dispersed or resource-constrained settings, digital tools and online platforms can facilitate effective teacher collaboration (Tatira, 2020). Asynchronous online PLCs empower educators to share resources, engage in discussions about pedagogical practices, and provide ongoing peer support (Mokoena, 2021).

Within the context of trigonometry instruction, technology offers a variety of tools that can potentially improve student engagement with abstract concepts. Interactive software, virtual manipulatives, and graphing calculators can all be leveraged to allow students to visualize and explore trigonometric relationships (Tatira, 2020). Technology can also support formative assessment by providing educators with real-time feedback and enabling them to tailor their instruction to address students' specific needs (Mokoena, 2021). Research suggests that when teachers integrate technology within PLC-driven practices, they are more likely to adopt and sustain innovative instructional strategies (Makandidze, 2020).

However, it is important to acknowledge that the successful integration of technology hinges on adequate training and ongoing support factors that can be particularly challenging in under-resourced environments (Makandidze,2020). To address this potential barrier, educational authorities, and NGOs can play a crucial role in providing targeted professional development opportunities and equipping educators with the necessary tools for effective technology implementation in their classrooms (Makandidze, 2020).

Challenges in Implementing Teaching Strategies in Trigonometry

Classroom Environment Constraints

The efficacy of trigonometry instruction can be significantly hampered by limitations inherent to the classroom environment. Research suggests a clear link between the physical and psychological characteristics of a classroom and student engagement, motivation, and ultimately, learning outcomes (Pule & Bhagwonparsadh, 2022). Factors such as class size, seating arrangements, resource accessibility, noise levels, and even lighting conditions can all have an unintended impact on student learning. As class sizes increase, the ability of instructors to provide individualized attention, crucial for successful trigonometry comprehension, may diminish (Chukwudi & Victor, 2021). While collaborative learning has proven to be an effective pedagogy in mathematics education, poorly designed classrooms can hinder student participation and collaboration (Visser et al., 2015).

The fostering of a nurturing classroom environment that encourages curiosity, calculated risk-taking, and active engagement is paramount for the cultivation of mathematical aptitude. Brown and Bredenkamp (2018) highlight the significant influence of the learning environment on student attitudes. In the face of challenges encountered during trigonometry studies, students may benefit from adopting a growth mindset, which views intelligence as malleable rather than fixed.

Overcoming these obstacles necessitates collaboration between policymakers, educational administrators, and educators themselves. Potential solutions include cultivating a growth mindset culture within classrooms, advocating for reduced class sizes, and optimizing the utilization of limited classroom space.

Teachers' Technological Proficiency and Access to Resources

The varied levels of technical expertise and access to pertinent resources amongst educators pose a significant challenge to the implementation of technology-based trigonometry teaching strategies (Abadom & Charles, 2022). Within the domain of digital education, the utilization of technology-enhanced learning methodologies has garnered recognition as a powerful tool for fostering student engagement and improving learning outcomes in subjects like trigonometry, which can be particularly demanding for students (Brown & Bredenkamp, 2018). However, the effectiveness of these strategies hinges on the instructors' comfort level and technical proficiency.

A growing body of research underscores the substantial influence of teachers' technical expertise on their preparedness and capacity to integrate technology into their pedagogical practices (Makamure & Jojo, 2022). For instance, educators who lack experience using dynamic geometry software might encounter difficulties incorporating it into their

trigonometry lessons. This could potentially hinder, rather than facilitate, student learning.

Limited availability of requisite technological resources presents another significant obstacle. This is particularly pertinent for institutions with constrained resources and inconsistent access to technology, such as those within the Alfred Nzo West Education District (Crompton, Burke, & Gregory, 2017). Schools may lack the necessary equipment to implement technology-integrated instruction, such as reliable internet access or a sufficient number of devices for each student.

To address these challenges, targeted teacher training programs are essential to bolster technical proficiency. Additionally, a commitment from educational stakeholders towards improving infrastructure and enhancing resource accessibility is critical. In conclusion, any proposed revisions to trigonometry teaching methodologies must take these practical constraints into account.

Learners' Preconceived Attitudes towards Mathematics

This analysis explores the complexities of employing effective teaching tactics with learners who possess pre-conceived notions about mathematics, particularly trigonometry. A growing body of research underscores the significant influence of student attitudes on their engagement, academic performance, and overall educational experiences within mathematics (Mapaire, 2016). Trigonometry, often regarded as one of the most challenging mathematical domains, appears especially susceptible to these psychological factors. It is noteworthy that students harbouring negative attitudes towards mathematics may exhibit a diminished receptivity to learning. The inherent intricacy and abstract nature of trigonometry frequently evoke anxieties within students (Dhlamini, 2016). This can lead to a decline in motivation and interest, ultimately hindering the effectiveness of pedagogical approaches. Furthermore, prior negative experiences in mathematics can contribute to diminished confidence and a cycle of underachievement (Setoromo & Hadebe-Ndlovu, 2020). Mathematics, in particular, appears to be a subject where confidence plays a crucial role. Past missteps can erode students' self-esteem and discourage them from engaging with trigonometry. Effective instruction in trigonometry necessitates the recognition and subsequent mitigation of these preconceived notions. Therefore, pedagogical strategies should be designed to cultivate positive attitudes, bolster self-esteem, and ignite a sense of intrigue and excitement surrounding trigonometry.

METHODOLOGY

Research Paradigm

This study adopted a constructivist methodology, acknowledging the role of individual knowledge construction through experiences and interactions (Bryman and Bell, 2019). Constructivism served as a pertinent framework given the study's aim to explore teachers' perspectives and experiences in teaching trigonometry. It inherently recognizes the influence of social and cultural contexts in shaping these experiences.

Research Design

Using a qualitative methodology, the study sought to gain an in-depth understanding of the multifaceted nature of trigonometry instruction within the Alfred Nzo West Education District. This approach enabled the researchers to explore the nuanced experiences and perspectives of educators, along with the external factors that shape educational practices in the district (Theron, 2018).

Participants

Six participants were involved in this study, comprising diverse educational backgrounds and teaching experiences. The participants included:

1. Public School Teacher (Participant 1)
2. Mathematics Subject Advisor (Participant 2)
3. Boarding School Educator (Participant 3)
4. Public School Teacher (Participant 4)
5. Private School Teacher (Participant 5)
6. Multiracial School Teacher (Participant 6)

Selection Criteria

To ensure the results were representative of a variety of learning environments and experiences, participants were purposefully sampled (Patton, 2015). This approach aimed to

capture a broad range of perspectives on trigonometry teaching issues. Selection criteria included years of teaching experience, school type (urban, rural, etc.), and school social setting (socioeconomic status) to create a diverse sample.

Research Questions

The primary research question guiding this study was: What challenges do educators face in implementing teaching strategies for trigonometry in the Alfred Nzo West Education District?

Data Collection

Semi-structured was use as a instrument to collect data.

Ethical Considerations

In this study, ethical considerations were paramount. Following informed consent procedures, all participants were apprised of the research objectives and their right to withdraw at any point (Arifin, 2018). To ensure participant confidentiality, data were anonymized, and interview records were securely stored.

Data Analysis

Thematic data analysis was used for this study. The research participants in this study brought forth a rich tapestry of experiences and perspectives, shaped by the unique mandates of their institutions, the educational settings they navigated, and their prior professional backgrounds. To facilitate a deeper understanding of how these factors influenced their views on trigonometry instruction, this section delves into the individual profiles of the six participants. For ease of reference, participants have been assigned numerical identifiers (1-6).

***Participant 1*:** A public-school educator with three years' experience specializing in mathematics education. Prior to this role, Participant 1 honed their teaching skills in physical sciences. Currently, they serve a low-income student population within a public-school setting, where a considerable number of students grapple with mathematics.

***Participant 2*:** A highly experienced mathematics subject advisor, serving as an invaluable resource for supporting and guiding mathematics educators across the region. Participant 2's insights are informed by years of observing classroom practices and student performance data. This wealth of experience positions them as a significant source of informed suggestions on mathematics pedagogy.

***Participant 3*:** A public-school educator with a distinguished career spanning 22 years, encompassing a diverse socioeconomic student body. Participant 3 underscores the critical role of well-equipped classrooms and the strategic integration of technology to facilitate the comprehension of challenging mathematical concepts.

***Participant 4*:** A 32-year-old public-school educator with a decade of experience specializing in Grade 12 mathematics. Participant 4 draws upon their experiences in both rural and urban settings, offering comparative perspectives on educational challenges and potential solutions. They advocate for a differentiated approach to instruction, tailoring methods to address the specific needs of their learners.

***Participant 5*:** A relatively new mathematics teacher with 12 years of experience primarily within private schools. They also hold valuable experience from a year spent at an independent school serving a predominantly middle-to-low-income student population, often residing with grandparents. Although facing limitations with restricted internet access outside of school hours, this participant emphasizes the importance of fostering creative teaching methods and leveraging digital tools within their pedagogy.

***Participant 6*:** A seasoned educator with 20 years of experience, currently teaching at a multiracial school with a richly diverse student body. Participant 6 is prepared to discuss the challenges associated with maintaining high academic standards in such a heterogeneous learning environment. Their experience includes utilizing innovative approaches such as WhatsApp to provide additional support and assigning supplementary tasks to enhance student learning outcomes.

This analysis underscores the heterogeneity of the educational contexts and experiences represented by the participants. Acknowledging this diversity is paramount to comprehending the challenges and successful strategies encountered in different teaching environments.

For instance, Participant 1 exemplifies a novice educator, whereas Participant 2 contributes extensive expertise and a repertoire of successful teaching methods.

Building upon the scholarship of Iqbal et al. (2019), this study recognizes the potential influence of teacher experience and the diversity of the school environment on instructional effectiveness and student outcomes. As Iqbal et al. (2019) further contends, teacher competence and quality are important factors impacting student achievement.

Validity and Credibility

Member checking was used to make sure the data was accurate and trustworthy. This let the users check and confirm the correctness of the transcribed data and emerging themes (Merriam and Tisdell, 2015). Triangulation was also used to make the results more reliable by comparing data from different people and settings (Patton, 2015).

To ensure data accuracy and trustworthiness, this study employed a two-pronged approach. First, member checking was utilized, allowing participants to review and confirm the veracity of their transcribed interviews and the emerging themes identified within the data (Merriam and Tisdell, 2015). Secondly, triangulation was implemented by collecting data from diverse sources and settings (Patton, 2015).

FINDINGS AND DISCUSSIONS

Theme 1: Current Teaching Strategies in Trigonometry

Use of Traditional Teaching Methods

Traditional lecture-based methods remain prevalent in the Alfred Nzo West Education District, as suggested by participants. Teachers reported heavily relying on chalk-and-talk instruction, utilizing the chalkboard to present mathematical concepts and solve problems. This approach appears to be particularly well-established in public and rural schools with limited resources. Participants indicated that these methods often combine with memorization and practice exercises to solidify foundational concepts, such as the CAST diagram and reduction formulae.

The interview data revealed key insights regarding the advantages and disadvantages of traditional teaching methods. While participants acknowledged the effectiveness of these methods in conveying core mathematical concepts, they also expressed concerns about a lack of student engagement and differentiation to address individual learning needs. For instance, Public School Teacher Participant 1 highlighted the difficulty students face in grasping the application of trigonometric identities using traditional methods, particularly when instruction lacks real-world contextualization.

Quoted Responses:

"I rely heavily on the chalkboard to explain trigonometric concepts. It's the most straightforward way to present the material, but it does not always engage learners effectively." (Participant 1)

"In my experience, repetitive practice on the chalkboard helps learners memorize formulas, but understanding their application is a different story." (Participant 3)

"Using the chalkboard allows me to walk through each step of a problem, which is essential for some learners to understand. However, it doesn't cater to all learning styles." (Participant 6)

"Traditional methods of teaching are what I am comfortable with, but I can see that they are not enough for many students, especially those who struggle with the basics." (Participant 5)

"Chalk-and-talk is how I learned, and it works for me, but I do notice that some learners need more interactive ways to grasp the concepts." (Participant 4)

According to (Mthembu et al,.2024) traditional techniques offer a structured and familiar framework for introducing trigonometry concepts but research suggests they may not cultivate deep understanding or engagement. This necessitates a shift towards more dynamic and varied pedagogical approaches.

While direct instruction can equip students with problem-solving techniques (Echazarra et al., 2016), it may not foster transferable knowledge or long-term retention (Echazarra et al., 2016; Schoenfeld, 2016). Schoenfeld (2016) emphasizes the importance of student autonomy and ownership in knowledge construction for fostering meaningful mathematical understanding.

Aligning topics based on their procedural connections can enhance learning by enabling students to leverage prior knowledge in new contexts (Cai et al., 2017). Integrating real-world applications can further increase engagement and understanding (Cai et al., 2017). As highlighted by participants in a study, traditional methods should be supplemented with real-life examples and contextually relevant problems (e.g., Cai et al., 2017).

Therefore, while traditional methods remain prevalent in the Alfred Nzo West Education District, their effectiveness can be augmented by incorporating more hands-on and application-oriented approaches. This shift is necessary to promote deeper mathematical understanding and cater to the diverse learning needs of all students (Lessani et al., 2017).

Integration of Technology

Participants indicated a limited integration of technology in mathematics instruction within the Alfred Nzo West Education District. Interview data revealed a disparity in practices: some teachers utilized technology to enhance student learning, while others faced challenges in accessing digital tools and devices. Notably, participants who did leverage technology emphasized its effectiveness in concretizing abstract mathematical concepts.

According to the interviews, 33% of teachers who regularly used technology reported employing GeoGebra and other instructional applications provided by the Department of Education. These tools were found to be particularly helpful in promoting student understanding of graphical transformations (e.g., shifting) and relationships between functions. Participant 3 further corroborated the benefits of technology, stating that these tools can "facilitate student learning of three-dimensional mathematics and graph development." The data also suggest that participants viewed online video lessons and resources as potential supplements to classroom instruction, fostering extended learning opportunities beyond the school environment.

Quoted Responses:

"I have started using GeoGebra to demonstrate trigonometric concepts. It helps learners visualize the problems, which is something that traditional methods fail to do." (Participant 2)

"Technology, when available, allows me to create interactive lessons that engage learners more effectively than just writing on the chalkboard." (Participant 5)

"Using educational apps has made it easier for learners to grasp complex ideas. They can manipulate the graphs and see the effects in real-time." (Participant 4)

"The lack of internet access at our school is a major barrier. We rely on downloaded resources and offline apps, but it's not the same as having full access." (Participant 3)

"I use video tutorials to help learners with their homework. They can watch and re-watch until they understand, which is something they appreciate." (Participant 6)

These examples show how technology can totally change how trigonometry is taught and the real-life issues that teachers have to deal with. According to Prabowo et al (2018) learners show interest in digital tools can help in learning mathematics faster, which makes sense given how well technology can improve learner understanding and visually seeing the effects of angles in a triangle when angles are changed using GeoGebra. Hsbollah and Hassan (2022) show that technology might be able to make learning more active and fun than the old ways. People who took part in the studies said that technology helps them see and understand mathematical ideas, which supports what Hsbollah and Hassan (2022) said.

However, integrating technology effectively necessitates addressing limitations. 67% of the participants had problems with technology, they indicated that they have no access to the internet, which hinders their effective use of technology. Lessani et al. (2017) and Hsbollah and Hassan (2020) emphasize the importance of equitable access to technology and the corresponding need for infrastructure, teacher training, and ongoing support. These studies demonstrate that technology integration requires infrastructure, teacher training, and continuing support.

Innovative Teaching Approaches

Participants 1 and 4 have pointed out that the split classroom approach works especially well. With this method, learners learn new material at home using video lessons and other tools. During class time, they engage in tasks, work out problems, and teach each other. Participants

indicated that this makes learning fun and helps students get a deeper understanding of the subject. Additionally, it gives teachers chance to meet the needs of each student during class time.

Quoted Responses:

"The flipped classroom method has been very effective. Learners come to class prepared to discuss and solve problems, which makes the learning process more engaging." (Participant 5)

"I have seen significant improvements in learner performance since I started using group work and peer teaching. It allows learners to learn from each other and clarify doubts immediately." (Participant 3)

"Using real-life examples and applications of trigonometry has helped learners understand the relevance of what they are learning. It makes the concepts less abstract." (Participant 4)

"Collaborative learning and peer teaching have transformed my classroom. learners are more confident and willing to participate in discussions." (Participant 2)

"Individualized extra lessons are crucial for addressing specific areas where learners struggle. This one-on-one time helps me tailor my instruction to their needs." (Participant 6)

These snippets show that the flipped classroom format and collaborative learning improve the learners' trigonometry engagement and knowledge. Modern educational philosophies emphasise active learning, student agency, and social learning. Moreover, Dodds (2015) found that the flipped classroom format improves STEM student results because flipped classroom pupils had higher conceptual comprehension and problem-solving abilities.

In addition, literature by Johnson and Johnson (2018) and Gillies (2016) on collaborative learning found that cooperative learning improves learners' success and interdependence. Their findings support participants' perceptions that peer teaching and group activities boost learners' confidence and clarify questions quickly.

However, implementing these creative methods is difficult. For instance, participants said these strategies work best when learners are self-directed and collaborative. Some schools may lack resources and facilities to implement such ideas. O'Flaherty and Phillips (2015) emphasise the need for preparation, support, and scaffolding to successfully use flipped classrooms and other creative teaching techniques.

Innovative trigonometric teaching methods have improved learners' involvement and knowledge. These tactics follow current educational ideas and are validated by empirical research, but they need careful preparation, sufficient resources, and continued support. To maximise the advantages of new trigonometric teaching approaches, these problems must be addressed.

Theme 2: Challenges in Implementing Teaching Strategies

Sub-theme: Resource Constraints

The semi-structured interviews show that resource restrictions hinder effective trigonometry education in the Alfred Nzo West Education District. Participants consistently highlighted the lack up-to-date textbooks and technological tools, which makes it hard to teach in an engaging manner. Public School Teacher Participant 1 emphasised that resources are frequently obsolete or inadequate to serve all learners. According to participants, budget constraints restrict instructors from being innovative and force them to use conventional approaches.

Boarding School Educator Participant 3 elaborated on the infrastructural challenges, noting that many institutions lack the necessary infrastructure for technology integration. This participant highlighted the potential of GeoGebra, a dynamic geometry software, to enhance learning by enabling students to visualize and interact with trigonometric concepts. However, owing to resource limitations, most schools lack the essential combination of computers and reliable internet connectivity. This restricted reliance on traditional "chalk-and-talk" methods limits students' exposure to diverse learning modalities, which is particularly crucial for subjects like trigonometry that involve abstract concepts.

Quoted Responses:

"We don't have enough textbooks for every student, and the ones we do have are very old

and sometimes missing important information." (Participant 1)

"Our school lacks the necessary technology, like computers and internet access, which makes it impossible to use interactive tools that could help students understand trigonometry better." (Participant 3)

"We often have to rely on photocopies of old notes and textbooks, which are not always clear or comprehensive." (Participant 4)

"Without access to digital resources or modern teaching aids, we are stuck with the traditional methods, which aren't always effective for all students." (Participant 5)

"I would love to use more innovative teaching strategies, but without the necessary resources, it's just not possible." (Participant 6)

The study identified resource limitations as a key factor hindering effective trigonometry instruction. Teachers often rely on outdated methods due to a lack of access to modern textbooks and technological tools. However, these traditional methods may not be universally effective for all learners, further exacerbating the issue. Furthermore, the absence of professional development programs to equip teachers with strategies for managing resource constraints creates a compounding effect.

These findings align with existing research highlighting the disparity in resources between impoverished schools and their counterparts. Mulenga and Mwanza's (2019) investigation into educational tools in sub-Saharan Africa similarly underscores the lack of materials and facilities faced by students and teachers. Altinok and Kingdon (2020) further solidify this connection by demonstrating a positive correlation between school funding and student performance.

The current educational landscape emphasizes the potential of technology to enhance student learning in mathematics classrooms. Mbugua (2019) advocates for the use of digital tools to promote engagement and improve mathematical understanding. However, the successful implementation of blended learning approaches hinges on the presence of appropriate frameworks, a challenge exemplified by the Alfred Nzo West Education District.

To improve trigonometry instruction within the Alfred Nzo West Education District, a multi-pronged approach targeting resource constraints is imperative. Equipping schools with up-to-date textbooks and technological resources is a crucial first step. Additionally, providing teachers with professional development opportunities focused on instructional strategies that can be adapted to limited-resource environments is essential. This approach aligns with best practices observed globally and holds the potential to significantly enhance student achievement in mathematics.

Sub-theme: Learner-Specific Challenges

Interview findings revealed significant learner-specific barriers that impede trigonometry instruction. A recurring theme was the lack of foundational mathematical skills among many Grade 12 students. Public School Teacher Participant 1 emphasized how students' struggles with basic operations, like addition and subtraction, impeded their ability to grasp complex trigonometric functions. This deficiency in essential mathematical prerequisites can lead to frustration and disengagement in trigonometry.

Boarding School Educator Participant 3 further highlighted the negative impact of mathematics anxiety on student performance. The perception of mathematics being difficult and uninteresting discourages students from actively participating in lessons and seeking help. Previous negative experiences in mathematics can exacerbate this issue, lowering students' confidence and motivation to learn.

Quoted Responses:

"Many of our students come into Grade 12 without a solid understanding of basic math concepts, making it very difficult for them to keep up with trigonometry." (Participant 1)

"The biggest challenge is changing the students' mindset. Most of them believe that mathematics is hard and not worth their time, which affects their learning." (Participant 3)

"There are students who just give up before they even start because they've struggled with math for so long." (Participant 2)

"We spend a lot of time going over basic concepts that they should have mastered in earlier grades, which takes away from the time we can spend on trigonometry." (Participant 4)

"The negative attitudes towards math are a big barrier. Many students are afraid to even try because they expect to fail." (Participant 6)

By examining these examples, it becomes evident that various student-specific challenges, such as deficiencies in foundational mathematical concepts or a general dislike for mathematics, can significantly hinder the effectiveness of trigonometry lessons. To cultivate a more confident learning environment and bridge these knowledge gaps, targeted solutions are necessary. These findings resonate with broader research in mathematics education and align with existing literature. For instance, Boaler's (2016) study underscores the influence of student mindsets and attitudes on mathematical achievement. It highlights how negative attitudes or self-doubt can impede learning. To bolster student confidence in their mathematical abilities, Boaler (2016) emphasizes the significance of fostering a positive learning environment. Furthermore, Boaler's (2016) research on mathematical growth aligns with the participants' emphasis on addressing foundational weaknesses. The study suggests that focused support in earlier grades equips students with a stronger foundation for success in advanced mathematics, corroborating the participants' perspective on the importance of rectifying fundamental issues to enhance trigonometry learning.

Sub-theme: Time Constraints

The interview data revealed that time constraints act as a significant barrier to effective trigonometry teaching strategies. Participants consistently highlighted the extensive nature of the trigonometry curriculum, which demands that instructors cover a multitude of challenging concepts within a compressed timeframe. A public-school teacher (Participant 1) expressed concern that the pressure to complete the curriculum before final examinations often leads to rushed lectures, ultimately hindering students' comprehension of the subject matter. This sentiment was echoed by a subject math advisor (Participant 2) who pointed out that the prescribed pacing guidelines set forth by the education department fail to account for the varied learning paces of students. Strict adherence to such timelines restricts opportunities for remedial instruction and in-depth exploration of complex concepts. Furthermore, the implementation of interactive and technology-based learning strategies, while potentially beneficial, is often impeded by limited instructional time, as these approaches generally require more extensive preparation and in-class application.

Quoted Responses:

"The syllabus is too broad, and there isn't enough time to cover everything in detail. We often have to rush through important concepts." (Participant 1)

"The pacing guide is too strict. It doesn't allow for any flexibility to go back and review concepts that students are struggling with." (Participant 2)

"We barely have enough time to finish the syllabus, let alone incorporate new teaching methods or technology." (Participant 3)

"The time constraints force us to prioritize completing the syllabus over ensuring that students actually understand the material." (Participant 4)

"There's so much pressure to cover all the content that we often have to move on before students are ready." (Participant 5)

These snippets demonstrate how time constraints can negatively impact trigonometry training. The pressure to adhere to a strict timetable and complete a comprehensive syllabus within a limited timeframe may cause educators to prioritize covering a wider range of topics at the expense of in-depth exploration. This approach can hinder students' grasp and long-term retention of fundamental trigonometry concepts.

Scholarly literature corroborates the notion that time constraints can detrimentally affect educational quality. Berliner et al (2018) identified that restricted instructional time in schools limits the feasibility of covering the entire curriculum. Berliner argues that inflexible pacing and overly ambitious syllabi constrain opportunities for varied pedagogical approaches and targeted interventions to address the diverse learning needs of students.

Theme 3: Suggested Improvements to Teaching Strategies

Thematic analysis explores the suggested improvements to teaching strategies proposed by the participants. The findings for this theme

are presented under the following sub-themes: enhancing training and support for educators, improving teaching resources, and increasing parental and community involvement.

Enhancing Training and Support for Educators

Qualitative data analysis of the semi-structured interviews revealed a unanimous consensus among participants regarding the necessity for enhanced teacher training and support within the Alfred Nzo West Education District. Findings highlighted a perceived inconsistency in current training programs, which participants suggested often fall short of adequately equipping educators to address the diverse needs of their learners across a spectrum of backgrounds and mathematical abilities. Public school teacher participant one elaborated on this point, stating that while professional development opportunities exist, their frequency and depth in relation to practical pedagogical strategies for mathematics instruction were deemed insufficient. Furthermore, participant three, representing a boarding school, underscored the criticality of ongoing professional development tailored to the specific challenges encountered by educators within their unique school environments.

Thematic analysis of the interviews additionally unveiled a widespread sense of unpreparedness amongst teachers regarding the integration of technology to enrich their lessons. Mathematics subject advisor participant two specifically noted the infrequent utilization of engaging software applications such as GeoGebra, a valuable tool for fostering learner comprehension of complex mathematical concepts. This underutilization of technology, a potentially transformative force in education, presents a significant missed opportunity for educators.

Quoted Responses:

"The workshops we attend are helpful but not enough. We need more frequent and detailed training sessions." (Participant 1)

"There's a significant gap in continuous professional development, especially focused on the latest teaching strategies and tools." (Participant 2)

"Most of us are not well-versed with tools like GeoGebra which can really help in making concepts clearer." (Participant 3)

"We often feel left to our own devices when it comes to improving our teaching methods for challenging topics like trigonometry." (Participant 4)

"The professional development programs need to be more practical and continuous rather than just theoretical." (Participant 5)

A thorough examination of these excerpts underscores the critical importance of systematic and ongoing professional development for educators. Well-designed programs should encompass not only fundamental pedagogical methods but also the effective integration of advanced technological tools. The current, ad hoc approach to training demonstrably fails to equip instructors with the necessary skills and knowledge to cultivate student interest in trigonometry. This deficit in training is particularly pronounced in resource-constrained public schools.

These findings, corroborated by contemporary research, illuminate the necessity for continuous professional development for educators. Darling-Hammond et al. (2017) reinforce this notion, positing that sustained professional development, characterized by collaborative learning and practical application, leads to demonstrably improved teaching practices and student outcomes. Notably, participants in the interviews emphasized the need for more frequent and practical training opportunities.

Desimone and Garet (2015) echo the sentiment expressed by the participants, advocating for comprehensive professional development programs that cater to the specific instructional needs of educators. They posit that ongoing programs should facilitate instructors' in-depth engagement with both subject matter and effective teaching practices. This methodology demonstrably enhances educators' pedagogical expertise and facilitates the integration of technology into the classroom.

In conclusion, the interview data and supporting educational research advocate for the implementation of continuous, practical, and technology-integrated professional development programs to bolster educator training and support within the Alfred Nzo West Education District. This approach has the

potential to significantly improve trigonometry instruction and, consequently, enhance student learning outcomes.

Improving Teaching Resources

The data from semi-structured interviews revealed a consistent need for enhanced teaching materials within the Alfred Nzo West Education District to bolster mathematical instruction. Participants frequently emphasized the challenges posed by outdated and inadequate resources. Public School Teacher Participant 1 highlighted the difficulty in acquiring comprehensive and current textbooks, necessitating reliance on dated materials. This constraint is further compounded by a lack of technological resources. Boarding School Educator Participant 3 specifically mentioned the limitations placed on utilizing engaging learning tools in environments lacking computers or internet access.

Furthermore, a call for more diverse and stimulating training materials catering to a variety of learning styles emerged from the interviews. The mathematics subject advisor for Participant 2 pointed out the current trigonometry teaching tools' overreliance on text-based methods, lacking in visual and interactive components to facilitate student comprehension. Limited funding constraints were identified as a contributing factor to the ineffectiveness of standard teaching methods in engaging learners and fostering improved performance.

Quoted Responses:

"We often have to make do with old and insufficient textbooks, which is a major obstacle." (Participant 1)

"Without access to computers and the internet, using interactive tools like GeoGebra is just not possible." (Participant 3)

"The resources we have are mostly text-based, which doesn't help much in explaining abstract concepts." (Participant 2)

"We need more engaging and diverse teaching aids to cater to different learning styles." (Participant 4)

"Relying on traditional methods due to lack of resources limits our ability to engage learners effectively." (Participant 5)

These excerpts highlight the critical role of up-to-date, inclusive, and appropriate teaching materials. Outdated and inadequate resources can hinder the development and implementation of innovative and effective pedagogical practices. This challenge is further exacerbated by technology shortages, particularly in under-resourced schools.

These findings underscore the significant impact of instructional materials on educational outcomes. As evidenced by UNESCO (2020), modern textbooks and technological tools are essential for fostering effective teaching and learning. Research suggests that well-equipped classrooms enhance student engagement and comprehension, especially in subjects like trigonometry that benefit from visual and interactive learning strategies (Abdelhali ,2017).

Schleicher (2018) emphasizes the importance of catering to diverse learning styles using a variety of instructional tools. The author argues that visual and interactive teaching methods can significantly improve students' conceptual understanding and knowledge retention (Schleicher, 2018). By incorporating such resources, educators can provide a more engaging and diversified learning experience for their students.

In conclusion, the Alfred Nzo West Education District requires a comprehensive upgrade of its teaching resources to include modern, diverse, and appropriate materials. The integration of recent academic literature, technological advancements, and interactive teaching tools (as supported by both the interviews conducted in this study and broader educational research) holds the potential to significantly improve trigonometry instruction and ultimately enhance student engagement and academic performance.

Increasing Parental and Community Involvement

The data gathered from semi-structured interviews highlights the positive influence of family and community involvement on Grade 12 mathematics performance. Participants consistently emphasized the significance of a supportive household environment and community engagement in bolstering student motivation and academic achievement.

Specifically, Participant 1, a public-school teacher, underscored the challenges faced by

many students from low-income backgrounds who experience limited parental involvement. They elaborated on how the absence of a strong support system can negatively impact student performance and cultivate a disinterest in mathematics.

Participant 3, an educator at a boarding school, emphasized the potential of family involvement to bridge the gap between home and school learning environments. They argued that parental support and encouragement are crucial factors motivating students to dedicate time and effort to their studies.

Furthermore, Participant 2, a Subject Mathematics Subject Advisor, underscored the critical role of community-based programs in supporting students, particularly in areas with limited resources. They advocated for initiatives that supplement classroom learning and provide additional opportunities for engagement with mathematics.

Quoted Responses:

"Many of our learners come from backgrounds where parental involvement in education is minimal." (Participant 1)

"Parental engagement can significantly improve learners' attitudes towards their studies." (Participant 3)

"Community programs can provide much-needed support and resources for learners." (Participant 2)

"When parents are actively involved, learners feel more supported and motivated." (Participant 4)

"There is a noticeable difference in performance between learners with supportive home environments and those without." (Participant 5)

The presented samples offer compelling evidence for a significant association between parental and community involvement, and academic achievement. The observed increase in participation appears to foster a more supportive and stimulating learning environment, consequently leading to improved performance in trigonometry.

These findings align with the existing body of literature advocating for family and community engagement in education. Epstein et al. (2019) posit a positive correlation between parental involvement in schooling and student outcomes, including academic performance, behaviour, and motivation. Their research underscores the importance of strengthening school-family ties to enhance learners' academic trajectories. Jeynes (2016) further suggests that after-school programs and community resources can provide valuable benefits for both schools and families. Jeynes (2016) emphasizes that such engagement is particularly crucial in resource-constrained settings where schools may struggle to fully meet the learning needs of their students.

DISCUSSION OF THE FINDINGS

The empirical study, based on semi-structured interviews with six participants from diverse teaching environments, provided valuable insights into contemporary teaching methods and their effectiveness. Both Public School Teacher Participant 1 and Boarding School Educator Participant 3 emphasized the significance of revisiting foundational concepts through one-on-one tutoring and direct instruction. This aligns with research by Fauth et al. (2019) who highlight the importance of a strong mathematical foundation.

In Separate School Participant 5's application of the split-classroom method, students reportedly demonstrated increased engagement and comprehension. This approach is supported by Hoshang and Hilda (2021), who advocate for active learning and group work to enhance students' grasp of mathematical concepts. Participant 3's experience further suggests that technology can facilitate the visualization of complex ideas, leading to improved student understanding (Abramovich et al., 2019).

Even though the study yielded positive results, it also identified significant challenges. Issues related to resource limitations and large class sizes emerged frequently, particularly within public schools. The first and fourth participants emphasized that these constraints hinder the implementation of personalized teaching methods and technological tools. These findings align with existing research on the impact of resource availability on teacher efficacy (Hanushek and Woessmann, 2017).

Furthermore, the socio-economic background of learners emerged as a critical factor influencing academic achievement. Participants underscored the importance of fostering greater parental and community involvement in

supporting student success. This aligns with Epstein's (2018) framework for collaboration among schools, families, and communities, which has been demonstrated to improve student outcomes.

Real-world data also indicated the effectiveness of individualized instruction in catering to diverse learner needs. Participant 6, a public-school teacher, highlighted the significance of employing a variety of projects and assessments to address the needs of learners with varying skill levels. This approach is supported by Tomlinson (2017), who advocates for differentiated instruction to ensure all learners receive appropriate tasks and support, thereby promoting equitable learning opportunities.

Recommendations of the Study

The investigation into trigonometry teaching methods within the Alfred Nzo West Education District aimed to identify strategies for enhancing Grade 12 learner achievement. This exploration likely yielded a range of recommendations, which presumably address existing challenges and incorporate successful practices from other contexts.

Enhanced Professional Development for Educators

Continuous professional development (CPD) programs with a specific focus on effective mathematics pedagogy are essential for educators in this field. Regular, targeted training equips them with fresh instructional approaches and keeps them abreast of curricular updates. The critical role of ongoing professional development in enhancing teacher efficacy is well-documented in the literature. For instance, Darling-Hammond, Hyler, and Gardner (2017) emphasize the significance of CPD in fostering teacher growth and development. Desimone and Garet (2015) further underscore the importance of incorporating collaborative learning opportunities within CPD programs, allowing teachers to share best practices and develop a network of support (Desimone and Garet, 2015).

Integration of Technology in Teaching

Consideration should be given to the potential of technology-based trigonometry instruction to enhance student engagement and understanding. Interactive tools, such as GeoGebra, can facilitate a deeper conceptualization of complex trigonometric concepts (Abramovich, 2019). To maximize the pedagogical benefits of such technology integration, schools should ensure sufficient technical resources and provide instructors with opportunities to develop proficiency in their use.

Parental and Community Involvement

Parental and community engagement are increasingly recognized as significant factors influencing student achievement (Epstein, 2018). Epstein's framework of school, family, and community partnerships emphasizes the collaborative effort required to foster student success. Schools can strengthen these partnerships by establishing clear communication channels with parents, and by offering workshops and information sessions that empower families to be active participants in their children's learning journeys.

Differentiated Instruction

Differentiated instruction can address the varied needs within a classroom. Tomlinson (2017) emphasizes the importance of employing diverse instructional approaches to cater to the individual learning styles and learning gaps of all students. Teachers can leverage formative assessments to identify these gaps and strategically adjust their teaching methods to ensure all students have the opportunity to thrive.

Targeted Interventions for Foundational Skills

Strong performance in trigonometry is contingent upon a solid foundation in foundational mathematical skills established in prior years. Starkey (2019) emphasizes the importance of addressing learning gaps early on to prevent students from encountering difficulties in more challenging subjects. To ensure a robust mathematical background for all learners, schools should implement targeted interventions such as remedial classes and tutoring programs.

Resource Allocation and Support

Resource constraints must be addressed to facilitate the implementation of innovative instructional practices. Schleicher (2018) emphasizes that proper financial investment and strategic resource allocation are integral to achieving improved educational outcomes. To this end, schools within the Alfred Nzo West

Education District should be equipped with a sufficient supply of textbooks, technological tools, and supplementary instructional materials.

Collaboration and Peer Learning Among Educators

Fostering collaboration among educators through Professional Learning Communities (PLCs) can enhance pedagogical practices (Spangenberg, 2021). Johnson and Johnson (2018) posit that collaborative learning can benefit both instructors and students. PLCs provide a platform for educators to share effective strategies, discuss instructional challenges, and co-construct solutions (National Council of Teachers of Mathematics, 2020). This collaborative approach can cultivate a shared understanding of best practices in trigonometry instruction within the specific context of the Alfred Nzo West Education District.

Limitations of the Study

Despite its discoveries, this study has significant drawbacks.

Sample Size and Generalizability

Five educators and one subject advisor participating from schools within the Alfred Nzo West Education District were included in the study. While the findings provide valuable insights, their generalizability to the wider educator population in the district or other contexts may be limited. A larger sample size could yield more comprehensive and nuanced data in future studies.

Data Collection Method

The study primarily relied on semi-structured interviews for data collection. While this approach facilitated a nuanced understanding of participants' perspectives, it may have introduced bias into the results. Social desirability bias might have influenced participants to provide responses perceived as more favourable. Additionally, participants may have experienced difficulty articulating their experiences fully. To strengthen the reliability of the findings, triangulation of data sources could be employed in future studies. This could involve incorporating classroom observations, student tests, or other relevant documents alongside interview data.

Focus on Trigonometry

The study's focus on trigonometry teaching methodologies limits its generalizability to other mathematical concepts. Future research could explore instructional tactics for a wider range of challenging mathematical topics to illuminate effective pedagogical practices across the mathematics curriculum.

Suggestions for Future Studies

Building on the findings and limitations of this study, several suggestions for future research are proposed:

Longitudinal Studies

A longitudinal study design could offer valuable insights into the enduring influence of varied pedagogical approaches on students' trigonometry achievement. By tracking student learning trajectories over an extended period, this research method can illuminate which instructional methods cultivate the most sustained positive effects. This focus on long-term learning outcomes transcends the limitations of studies that solely assess immediate post-instructional gains.

Comparative Studies

Future research could compare districts or regions to see how socioeconomic conditions and resource availability affect teaching efficacy. Such research may discover cross-setting best practices. Future research could explore inter-district or inter-regional comparisons to investigate how socioeconomic contexts and resource disparities mediate teaching effectiveness. Such comparative studies can potentially uncover generalizable best practices that transcend specific settings.

Intervention Studies

Employing rigorous experimental or quasi-experimental designs, intervention studies can provide robust evidence regarding the efficacy of particular approaches. For instance, a study could examine the impact of a specific professional development program on teacher pedagogy and subsequent student achievement in trigonometry. This type of research advances causal understanding beyond simple correlation

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