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Instructional Practices in Secondary Mathematics Education in Kenya: A Review of Strategies and Impact on Student Achievement

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Abstract
Teaching mathematics is essential for influencing students' academic and professional paths and forming their futures. In Kenya, all secondary school pupils are required to take mathematics. The ongoing drop in math proficiency among students has raised serious concerns, leading educators and legislators to look for efficient solutions and a thorough examination of teaching methods in order to raise student achievement. A major barrier to engagement and success is the negative perception that many students have of mathematics, considering it to be a challenging and uninteresting subject. Effective teaching methods for mathematics are examined in this review, which also examines earlier studies, contrasts the findings of various researchers, and makes suggestions for enhancing math education.
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1.0 Overview

Given that mathematics is a required subject, the ongoing drop in performance in Kenyan secondary schools is still a serious concern (Yara & Otieno, 2010). This calls for a thorough analysis of the elements influencing this trend, with an emphasis on teaching strategies and possible areas for development (Yara & Otieno, 2010). A major factor in lower student engagement and achievement is the belief that mathematics is a challenging and uninspired subject (Mabena et al., 2021). Fostering excellence in mathematics education requires addressing the frustration felt by both teachers and students (Hungi et al., 2016). Students' motivation and engagement can be adversely affected by a lack of knowledge about the importance of mathematics in different career paths, which may result in disinterest and disengagement (Mabena et al., 2021). It is critical to acknowledge the critical role mathematics plays in promoting scientific and technological breakthroughs, which are necessary for a country's socioeconomic development (Mabena et al., 2021). Students' future academic and professional paths are influenced by mathematics, which opens up a wide range of career options.

2.0 Review of the Literature on Teaching Methods in Mathematics Education

Ineffective teaching strategies are common in mathematics classes, which may cause students to have misconceptions and only have a cursory grasp of mathematical ideas (Allotey, 2019). Effective teaching and learning of mathematics is further hampered by a lack of sufficient laboratory resources, equipment, and learning materials. Inequities in access to high-quality mathematics education are also a result of a weak technological infrastructure. The performance of students in mathematics has been a major concern on a global scale (Mabena et al., 2021). Lesson planning, subject matter expertise, pedagogical knowledge, classroom management skills, attention to struggling learners, assignment quality, exam preparation techniques, attendance, efficient use of class time, teacher attitudes, and emotional support are just a few of the teaching-related issues that students have voiced concerns about (Acharya, 2017). Resolving these problems is essential to advancing math education.

2.1 How teaching methods affect students' academic performance Students'

Success in mathematics is greatly influenced by the expertise and experience of teachers (Ansah et al., 2020). Furthermore, effective mathematics instruction depends on teachers' pedagogical content knowledge, pedagogical knowledge, and content knowledge (Baumert et al., 2009). It is crucial to remember, though, that professional development initiatives aimed at improving educators' comprehension of mathematics pedagogy and content have had little effect on student achievement (Gersten et al., 2020). Furthermore, teachers may be inclined to stray from implementing ambitious mathematics instruction if they feel a lot of pressure from teacher evaluation policies ("Journal for Research in Mathematics Education," 2023). In order for students to learn effectively, teachers must be aware of what they already know and what they still need to learn (Baumert et al., 2009). In addition, a good use of collaborative work gives students more chances to discuss, question, and improve their own and their peers' ideas, which creates a rich environment for problem solving. Last but not least, when students consistently encounter good classroom teaching techniques—like well-defined objectives, efficient time management, well-organized classroom management, high standards, and a supportive learning atmosphere—they perform better.

2.2 Kenyan secondary mathematics education's main obstacles

Students' understanding of mathematical concepts is severely hampered by ineffective teaching strategies. This results in a superficial comprehension, which then makes it difficult for them to apply what they have learned in new contexts. In mathematics education, addressing sociocultural issues like biases and stereotypes is essential. All students will benefit from this and achievement gaps will be reduced (Mangarin & Caballes, 2024). Both boys' and girls' math performance can be raised by using effective teaching techniques. However, a major barrier to effective math instruction is the lack of science labs, learning resources, and necessary equipment. Students' chances for experiential learning and real-world application of theoretical ideas are thus restricted. Furthermore, inequalities in educational opportunities are made worse by inadequate technology infrastructure. Students in underprivileged communities are disproportionately impacted by this, and it prevents them from accessing contemporary educational resources (Bohlmann & Pretorius, 2008; Insorio, 2024). Furthermore, a lot of parents typically have low levels of mathematical education and are preoccupied with long workdays (Maree & Stones, 2023). Research that looks at how home environmental factors affect math performance is needed.

2.3 Research and practice gaps

Previous studies have identified a number of significant obstacles in Kenyan secondary mathematics education, such as poor technology infrastructure, insufficient resources, and ineffective teaching strategies (Atta & Bonyah, 2023; Freitas & Spangenberg, 2019). Students' perception of mathematics as a challenging and dull subject is one of the many factors contributing to the decline in math proficiency in schools. Students' interest in mathematics may suffer from a lack of understanding and appreciation of the subject's importance in various professions. To find out how well certain interventions—like teacher professional development programs and incorporating technology into math classes—improve student outcomes, more research is required.

3.0 Theoretical foundations for teaching mathematics

In order to promote a deeper comprehension of the subject matter, effective teaching strategies in mathematics should highlight the connections between language, mathematical patterns, and representations (Miller & Armour, 2019). Effective problem-solving frequently depends more on students' understanding of mathematical ideas than on their rote memorization of steps (Kwame & Agbornu, 2020). Students' mathematical communication abilities and general comprehension can be greatly improved by encouraging them to express their thought processes and problem-solving strategies (Singley & Bunge, 2014). Accordingly, mathematical reasoning skills development should be given top priority in instructional practices so that students can think critically and logically when faced with challenging assignments both inside and outside of the classroom (Mukuka et al., 2023). Students must be actively engaged in the learning process in order to change from passive consumers of knowledge to active creators of their own mathematical understanding.

4.0 The objectives of the current systematic review

Three main objectives guided the current systematic review. Our *first* goal was to compile the existing knowledge on interventions that support students aged 5 to 16 in learning mathematics. *Second,* in order to help guide decisions regarding the development and application of future interventions, we sought to provide information about the variety of interventions currently in use as well as their efficacy. *Lastly*, in order to direct future research, we sought to identify gaps in the literature regarding both intervention types and student populations. Interventions were considered for inclusion in the review if they satisfied the following requirements: Participants had to be between the ages of 5 and 16 (inclusive); the intervention had to be given in an educational setting (school, for example); it had to be intended to enhance learning outcomes in mathematics (achievement, confidence, attitudes, and engagement); it had to report quantitative data on the intervention's efficacy (pre- and post-test scores, for example); and it had to be published in English. The following were the exclusion criteria:

i. Interventions that weren't given in a classroom and or/educational setting
ii. Interventions not intended to enhance learning outcomes in mathematics
iii. Research that failed to provide quantitative information regarding the intervention's efficacy
iv. Research that wasn't published in English

4.1 Sytematic review methodology

In accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, a systematic review was carried out. The review protocol was registered with the International Prospective Register of Systematic Reviews.

4.2 The search strategy

To find pertinent studies, relevant research articles and reports, a thorough search strategy was created. The following academic repositories and databases were searched, i.e. Education Resources Information Center (ERIC), PsycINFO, Web of Science, Scopus, and Google Scholar (Bah, 2022).

4.3 Search terms

"Mathematics" OR "numeracy" AND "intervention" AND "school" OR "classroom" were the search terms used. In addition to related keywords, the search terms included "mathematics education," "instructional practices," "Kenya," "secondary schools," and "student achievement." The inclusion criteria gave priority to research that examined instructional practices in secondary school settings in Kenya and other nations, looked into the relationship between instructional strategies and student achievement, and offered empirical support or theoretical understanding of successful approaches. Articles that did not specifically address mathematics education in Kenya, did not discuss instructional practices, or did not provide enough empirical evidence or theoretical significance were disqualified. Research design, sample characteristics, instructional interventions, outcome measures, and key findings were the main topics of data extraction from the included studies. For example, search strings like "Mathematical instruction AND secondary school OR high school," "Teaching strategies AND secondary mathematics AND student achievement," and "Technology AND mathematics instruction AND secondary school" utilized Boolean operators (Scells et al., 2020) to refine the search criteria and produce pertinent results. Searching for keywords such as "effective," "best practices," "student-centered," "mathematics achievement," and "teacher strategies" within the abstracts allowed for even more refinement. To provide a more thorough evaluation of the influence of different tactics on student outcomes, a meta-analysis was also taken into consideration in order to compile quantitative data on the efficacy of particular instructional interventions (Sood & Mackey, 2014).

5.0 Synthesis of findings

Stress and anxiety levels are rising among math teachers (Meeran & Wyk, 2022). Accountability systems that are linked to standardized test scores may be the cause of this stress, which could put pressure on teachers to give test-oriented instruction precedence over developing students' conceptual understanding (Yaw & Agani, 2023). Additionally, teachers may find it difficult to teach mathematics effectively if they lack the necessary pedagogical skills and content knowledge, which can result in frustration and burnout. Concerns have been raised by students regarding a number of teaching-related topics, such as lesson planning, subject and pedagogical knowledge, classroom management, accommodating slow learners, the caliber of homework and classwork, exam preparation, attendance, and contact time utilization. Students are also concerned about the attitudes of teachers, their methods of instruction, methods of continuous assessment, how they handle challenging subjects, how well they explain things, how they give examples, how they take notes, and how they use teaching and learning resources (Njiru, 2014). These elements may have a detrimental effect on both the teaching of mathematics and students' overall educational experiences. Teachers may stray from ambitious mathematics instruction if they feel a lot of pressure from teacher evaluation policies.

A study by Nandwa et al. (2015) looked into how teaching methods affect secondary school math proficiency. A behavioral objective-based approach, conventional instruction, BOB and PICT, and peer instruction enhanced with concept tests were all used in the study (Table 1). According to the study's findings, teachers should use these teaching techniques to raise their students' proficiency in mathematics. The results showed that all experimental groups outperformed the control group in terms of achievement, with the experimental groups outperforming the latter. It was discovered that BOB, PICT, and BO-PICT were effective teaching methods that could raise students' performance in mathematics. Additionally, the BO-PICT group had the highest achievement test mean score, indicating that performance is greatly improved by utilizing multiple strategies.

Table 1: Effects of mathematics ability on the performance of students.

Group	SD	No of students	Pre-test mean	Post-test mean	Mean gain
E1	14.61	N=80	30.1	60.2	30.1
E2	15.50	N=82	31.2	63.2	32
E3	12.87	N=84	31.1	66.4	35.3
C	10.54	N=82	30.6	42.4	11.8

Key: E1 = Behavioural Objective- Based strategy; E2 = Peer Instruction enriched with Concept Tests; E3 = both BOB and PICT; C = Conventional Instruction

The performance of E1 (Behavioral Objective-Based Strategy) significantly improved, as evidenced by its mean gain of 30.1, whereas E2 (Peer Instruction enriched with Concept Tests) showed a slightly higher mean gain of 32, indicating the effectiveness of the combination of peer instruction and concept tests. Nevertheless, E3 (Combination of BOB and PICT) showed the highest mean gain of 35.3, suggesting that combining the two approaches produced the biggest improvement. With the lowest mean gain of 11.8 compared to the strategies, C (Conventional Instruction, or the control group) demonstrated that traditional teaching methods were less successful in raising student performance. According to the findings, when compared to traditional instruction, active learning techniques—especially those that include behavioral objectives and peer instruction—significantly enhance student outcomes. The most successful strategy seems to be the combination of BOB and PICT. Thus, it was possible to draw the conclusion that BOB, PICT, and BO-PICT were more effective teaching methods that could enhance students' mathematical performance. Students' performance in mathematics was greatly enhanced by cooperative learning (Dimatacot & Parangat, 2022). Significant student interaction was encouraged by this method both within and outside of the classroom (Ahmadi, 2000). According to research, a cooperative setting helps students learn more efficiently (Dimatacot & Parangat, 2022). Additionally, students' attitudes toward mathematics improved, and they became more interested and motivated in the subject by participating in extracurricular activities (Ahmadi, 2000).

Compared to the control group, students in the experimental groups (Figure 1) made greater mean gains. In particular, the E1, E2, and E3 treatment groups outperformed the control group in terms of mean scores (60.2, 63.2, and 66.4, respectively) (Figure 1). E3, which used BO-PICT, performed better than the other experimental groups, according to a detailed analysis of the data. Figure 1: MAT pre-test and post-test mean comparison An F-ratio greater than the table value indicates a significant difference in performance between at least two groups, which was confirmed by the ANOVA test (Table 2).

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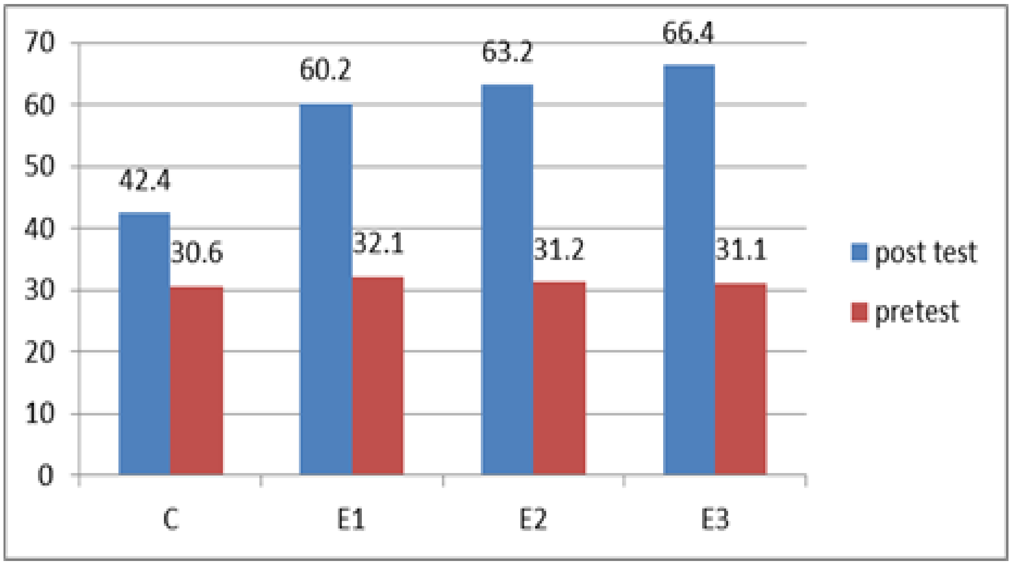

Figure 1: Comparison of MAT pre-test and posttest means

An independent samples t-test was used to ascertain the direction of these performance differences between the four groups. Each experimental group's mean score differed significantly from the control group's mean, favoring the experimental groups.

Table 2: ANOVA of MAT post-test results

SOURCE	D.F	S.S	M.S	F-RATIO	SIG
BETWEEN GROUPS	4-1=3	52734.5	17578.17	61.77	0.62
WITHIN GROUPS	327-4=323	92202.15	284.57		
TOTAL	326	144936.65	17862.74		

Additionally, Table 3 shows that there is no discernible difference between E1 and E2. Nonetheless, a notable distinction was noted between E3 and both E1 and E2. The t-test results were supported by the trend BO-PICT (E3)>PICT (E2)> BOB (E1) > C (TI) for the MAT measure, which was obtained using the Scheffe post hoc analysis procedure. Positive attitudes toward mathematics and improved student outcomes are more likely to be fostered by teachers who set high expectations for their students, give them difficult assignments, and create a positive learning environment.

Table 3: Results of an independent samples t-test of the MAT post-test scores

Instructional approach	N	Mean	SD	DF	Cal t	Cri t	Remark
E1	80	60.2	14.61	161	8.62	1.658	sig difference
C	82	42.4	11.46				
E2	82	63.2	15.5	163	9.77	1.658	sig difference
C	82	42.4	11.46				
E3	83	66.4	12.87	164	12.66	1.658	sig difference
C	82	42.4	11.46				
E1	80	60.2	14.61	161	1.268	1.658	No sig difference
E2	82	63.2	15.5				
E1	80	60.2	14.61	162	2.87	1.658	sig difference
E3	83	66.4	12.87				
E2	82	63.2	15.5	164	1.84	1.658	sig difference
E3	83	66.4	12.87				

SAQs (Figure 2) are valuable for assessing participants' ability to recall, analyze, and synthesize information rather than just recognizing answers in multiple-choice formats. They promote critical thinking and conceptual understanding, making them useful for gauging learning progress in pre-test and post-test evaluations. Unlike recognition-based assessments, such as multiple-choice formats, SAQs necessitate active reconstruction and articulation of knowledge, compelling learners to engage in deeper cognitive processing (Elshama, 2020).

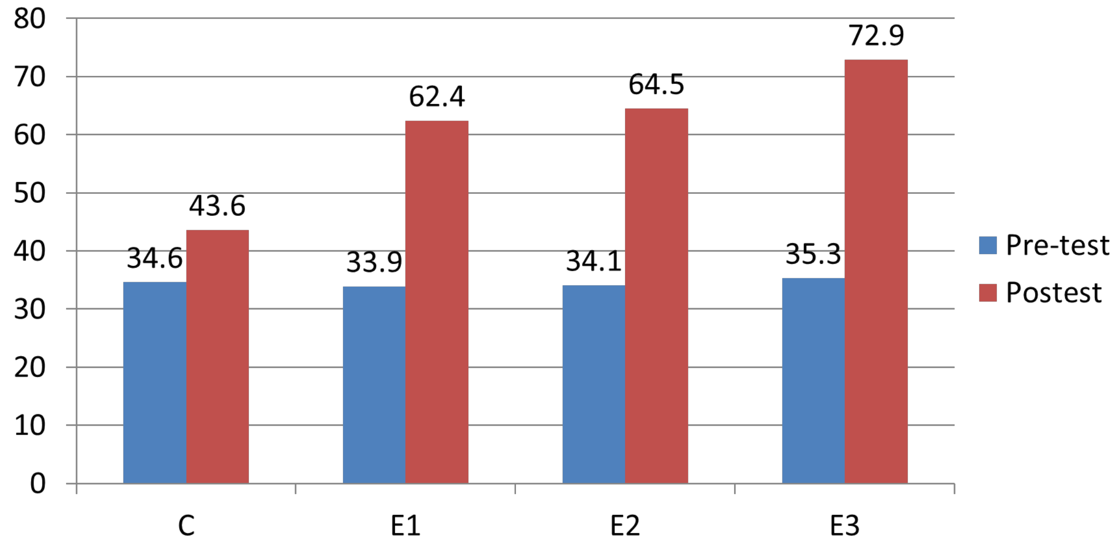

Figure 2: Short answer question (SAQ) pre-test and post-test mean comparison

Figure 2 illustrates a comparison of mean scores from a pre-test and post-test across four categories: C, E1, E2, and E3. The blue bars represent the pre-test scores, while the red bars indicate the post-test scores. A clear trend emerges, showing an improvement in scores across all categories, with post-test results consistently surpassing pre-test scores. In Category C, the mean score increased from 34.6 to 43.6, reflecting moderate progress. Category E1 experienced a significant rise, with the mean score moving from 33.9 to 62.4. Similarly, Category E2 demonstrated substantial improvement, as its score climbed from 34.1 to 64.5. The most remarkable enhancement occurred in Category E3, where the mean score surged from 35.3 to 72.9, indicating the highest level of advancement among all categories. This pattern suggests that an intervention or educational method introduced between the assessments contributed positively to the participants' performance. The notable increase in scores could be attributed to enhanced learning strategies, engagement techniques, or refined instructional methods. Research on pre-test and post-test evaluations frequently highlights the effectiveness of structured educational interventions in improving academic achievement. Black and Wiliam (1998) emphasize the role of formative assessment in fostering student progress, while Bloom's (1971) mastery learning approach demonstrates that targeted. These teaching methods fit in well with contemporary theories of education, especially those that stress constructivism, active learning, and cognitive development.

Constructivism: According to this theory, which was supported by Piaget and Vygotsky, students build their knowledge via interactions and experiences. Deeper understanding is fostered by encouraging students to actively engage with the material through strategies like Behavioral Objective-Based Strategy (E1) and Peer Instruction enriched with Concept Tests (E2). *Bandura's Social Learning Theory* emphasizes the value of learning by interaction and observation. This is supported by peer instruction (E2), which encourages cooperative learning settings where students can benefit from one another's knowledge while *Cognitive Learning Theory* concentrates on mental functions such as comprehension, memory, and problem-solving. By combining interactive peer discussions with structured objectives, BOB and PICT (E3) improve cognitive engagement. However, Kolb promoted *the experiential learning approach,* which places a strong emphasis on learning by doing. By promoting problem-solving and application-based learning, the active learning techniques employed in E1, E2, and E3 are consistent with this theory. These strategies support the notion that structured objectives, teamwork, and active participation result in improved learning outcomes and are representative of contemporary best practices in education.

5.1 Instructional strategies based on theories of experiential, cognitive, social, and constructivist learning

In particular, their focus on active learning, constructivism, and cognitive development shows how different instructional strategies align with modern educational theories (Yılmaz, 2011). A pillar of contemporary educational theory, constructivism holds that students actively create knowledge via their encounters and interactions with the outside world (Nandwa et al., 2015). This viewpoint, which was greatly impacted by Piaget and Vygotsky's work, emphasizes how crucial it is to involve students in activities that foster inquiry, critical thinking, and the integration of new and preexisting knowledge (Ahmadvand & Khoshchehreh, 2023). This method is demonstrated by techniques like the Behavioral Objective-Based Strategy (E1) and Peer Instruction enriched with Concept Tests (E2), which motivate students to actively engage with the material and promote deeper understanding through practical application and group problem-solving (Pundir & Surana, 2016). These techniques support the constructivist view of learning as a dynamic and iterative process by facilitating the transition from passive information reception to active knowledge construction. By highlighting the active role of the learner in the process of creating knowledge, instructional strategies that incorporate practical application—like design-based learning, problem-solving, and research-based learning—can also result in innovative education (Seechaliao, 2017). According to the constructivism learning theory, people will develop meaningful competencies and knowledge through their experiences (Efgivia et al., 2021). Constructivist methods place an emphasis on helping students build their knowledge and abilities through activity and reflection, as well as presenting new material within the framework of their prior knowledge (Alt, 2012; Pinho-Lopes & Macedo, 2014).

The main proponent of Bandura's Social Learning Theory highlights the importance of modeling, imitation, and observation in the learning process (Mayer, 2006). This theory is especially supported by peer instruction, which creates cooperative learning settings where students can share different viewpoints, observe, and discuss with one another to learn from one another. In addition to facilitating the learning of new information, this collaborative dynamic fosters the growth of social skills, communication abilities, and teamwork capacity—all of which are critical for success in both academic and professional contexts. Social engagement can improve knowledge creation, and students are allowed to develop their own answers and test out new concepts (Do et al., 2023). Students can express and change their opinions in a conversational setting by using group discussions. Constructivism maintains that learning is a social activity because people learn through interacting with others. According to Nandwa et al. (2015), cognitive learning theory focuses on mental functions like memory, comprehension, and problem-solving, all of which are essential for successful learning. This method is best illustrated by the combination of structured objectives and interactive peer discussions in the Behavioral Objective-Based Strategy with Peer Instruction and Concept Tests, which improves cognitive engagement. Because students actively process, analyze, and apply the material in meaningful ways in addition to being exposed to it, this synergistic approach fosters a deeper understanding of the subject matter. This active participation improves memory retention, builds critical thinking abilities, and fortifies cognitive pathways (Kamau et al., 2021). By giving students the chance to set objectives, track their progress, and get feedback, cognitive learning theory not only improves cognitive processes but also encourages motivation (Nandwa et al., 2015). The value of learning by firsthand experience is emphasized by Kolb's experiential learning theory (Binson & Lev–Wiesel, 2018; Murrell & Claxton, 1987). This theory is supported by the active learning techniques used, which motivate students to participate in application-based learning and problem-solving exercises. These methods give students the chance to use what they've learned in practical settings, which helps them grasp the subject matter more deeply and improves their capacity to apply what they've learned to new circumstances (Saavedra & Opfer, 2012).

Compared to traditional lecture-based instruction, these strategies give students first-hand experience, which can be more memorable and impactful. In the end, these tactics represent contemporary educational best practices, reaffirming that structured goals, teamwork, and active participation are important factors in enhancing learning outcomes (Wirth, 2007).

5.2 Findings from other math education researchers.

The achievement of students who adopted the Individualization for Mastery (IMA) approach and those who chose to use the CSA strategy instead of the IMA differs significantly. Students who used appropriate mathematical language (AML) and those who used verbal communication in mathematics (VCM) performed significantly better than those who used appropriate mathematical language (VCM) (Firmender, J. M. 2014). Students' performance in mathematics is influenced and determined by the various teaching strategies employed by the teachers. Therefore, in order to improve performance, math teachers must carefully consider their instructional strategies before beginning their lessons (Mutua, J. M.,2023). In support of the PICT group, Puma et al. (1993) discovered that small group learning has become a viable substitute for traditional instruction and has been shown to be successful in hundreds of studies worldwide. According to Brown (2002), learning objectives support the BOB group by making it simpler to write fair, thorough assessments, which in turn facilitates the development of good assessments.

5.3 Instructional practices and attitude development

The results unequivocally showed that the instructional strategy used for instruction had an impact on how attitudes were developed. It was determined that the Experimental groups outperformed the Control group.

Additionally, there was a noticeable impact on attitude development in the group with more practices. As stated by Hussein, Y. According to et al. (2023), students who received conceptual instruction developed more positive attitudes than their counterparts who received conventional instruction. Samuelsson, J. (2023) concluded that students' relationships with mathematics are impacted by activities that meet their basic psychological needs. According to Sinay, E. (2016), "instructional practices are incorporated into mathematics classrooms to improve students' mathematical abilities and attitudes." System-wide professional learning can help promote the adoption of these teaching strategies.

5.4 Suggested elements to be included in mathematics education

Without enforcing procedural steps, educators should pose difficult, rich, and complex problems that permit multiple entry points, a variety of approaches, scaffolding, and engagement (Githua & Njubi, 2013). Encourage students to work through open-ended problems and support their efforts by having them create and solve their own problems, work on problems that are representative of real-world situations, compare different approaches to solving problems, and point out common mistakes. Encourage students to mathematize their environment, cultivate their creativity, and give them chances to solve problems that call for ingenuity to help them become more creative in mathematics. Collaboration in mathematics should be encouraged and supported in the classroom. Encourage student collaboration in mathematics by integrating technology. Establish a classroom setting that encourages active learning and allows students to pretend to be mathematicians. To teach mathematics standards and establish an engaging classroom, use the Ontario College of Teachers' and NCTM's approved inquiry-based learning strategy, Three-part Mathematics Lesson Plans (Kamau et al., 2021). Make use of technology, like online tests, to point out students' errors rather than just their right answers. For students to learn mathematics more effectively, teachers should give them continuous feedback (Nandwa et al., 2015; Rakes et al., 2022). STEM activities are a useful way to give mathematics meaning because they enable students to form meaningful connections, develop critical thinking skills, and apply mathematical ideas in real-world situations. To effectively Support Computational Thinking, the particular mathematics incorporated into STEM activities needs to be clearly identified, taught, and discussed (Rakes et al., 2022). Math teachers should continue to place a high priority on traditional mathematical thinking and learning in the classroom while encouraging computational thinking (Nandwa et al., 2015). Additionally, research shows that manipulatives that are too realistic or visually stimulating can easily distract students, so it is crucial to use manipulatives with minimal visual distractions.

5.5 Techniques for enhancement of Maths education

A comprehensive strategy is required to address these complex issues. Curriculum reform, teacher preparation, resource distribution, and community involvement should all be included in this strategy. Furthermore, adopting cutting-edge teaching techniques like inquiry-based learning, group projects, and real-world applications can improve students' critical thinking and problem-solving abilities while also encouraging deeper engagement (Mwadzaangati, 2019). Students' appreciation of mathematics can be increased by highlighting the subject's significance in a variety of career paths. This piques their curiosity and inspires them to achieve success (Widyanti & Khabibah, 2020). Teachers may encourage students to embrace mathematics with zeal and tenacity and realize their full potential for success by fostering a positive attitude toward the subject and demonstrating its application to real-world situations. Furthermore, because they have little to no understanding of mathematics as a human or cultural product, many students typically struggle with the fundamentals of the subject (Weldeana, 2016). When developing digital learning materials, the most effective ways to convey important ideas must be considered in order to facilitate comprehension and encourage productive interaction with the content.

5.6 Suggestions for improving the teaching of mathematics

Multifaceted strategies that address resource allocation, instructional practices, and technological integration should be used to address the difficulties in mathematics education. This will encourage student motivation and engagement. For instance, it was advised that math teachers give students extrinsic incentives during math classes, like gifts and praise (Adom & Adu, 2018). This could be accomplished by utilizing interactive software, online simulations, and digital games to establish a dynamic and captivating learning environment (Saha et al., 2020). Students' motivation, problem-solving abilities, and conceptual comprehension can all be improved by this method (Bouzid et al., 2021). Teachers must receive training on techniques to foster positive attitudes toward mathematics and lessen math anxiety (Blazar & Kraft, 2016). There has been little evidence of an impact on student achievement from implementing professional development programs aimed at improving teachers' comprehension of mathematics content and pedagogy (Bautista, 2023; Furner & Duffy, 2022; Marticion, 2021). Teachers must be aware of what their students already know and what they still need to learn in order to effectively challenge and assist them in learning it (Greenes, 2009). To successfully address the current issues in mathematics education, teachers should create instructional strategies that include employing suitable techniques to influence students in ways that they want (Ezeddine et al., 2023). Teachers should closely examine the methods used in mathematics instruction after considering the challenges that currently exist, the needs of the students, and the goals that need to be achieved (Algani, 2019).

Designing mathematical exercises that actively engage students, foster critical thinking, and develop their problem-solving skills should also be a priority (Amo-Asante & Bonyah, 2023). According to a study, both students and teachers should actively participate in math instruction, with teachers giving each student a variety of engaging learning opportunities (Cường & Quang, 2020). Because learning resources now come from outside sources as well as within the classroom and are then used collaboratively in the classroom, the paradigm shift fosters creativity in the learning process (Murni et al., 2019). Most people agree that incorporating technology into the classroom is a good way to deal with math difficulties, which eventually improves performance when used wisely (Mokotjo & Mokhele, 2021). Technology integration has the potential to revolutionize mathematics education (Cîrneanu & Moldoveanu, 2024). Teachers must be proficient in using technology for integration to be successful, which greatly enhances students' learning of mathematics (Serin, 2017). In order to improve mathematics learning outcomes, strategies should be in place to guarantee that teachers receive adequate training and assistance when utilizing technology. Enough professional development should be provided to teachers so they can integrate technology into their lessons. Additionally, in order to successfully implement changes, teachers require assistance and training, highlighting the significance of ongoing professional development (López et al., 2022). For many nations worldwide, the necessity of integrating ICT into education has grown to be a significant concern (Atteh et al., 2020).

5.6 Conclusion

The review demonstrates the complex issues that secondary school mathematics instruction faces, especially in Kenya. These difficulties include poor teaching methods, a lack of resources, and unfavorable attitudes toward the subject. According to the review, teachers must look at efficient methods of teaching mathematics that help each student gain a thorough understanding of the subject while also encouraging a strong sense of mathematical agency and a positive mathematical identity (Wilkerson, 2021). The attitudes, convictions, and values of teachers have a big influence on how well students learn mathematics. The changes in primary school teachers' learning content knowledge and pedagogical content knowledge for teaching mathematics should be the main focus of qualitative research (Miller & Armour, 2019). Teachers think it's beneficial to use a variety of strategies (Lynch & Star, 2014). One benefit is that it gives kids the chance to interact with math in a variety of ways and gives them the chance to connect both inside and outside of the classroom (Bii et al., 2019). Focusing on integrating mathematical concepts, representations, and the relationships between them may be advantageous for educators. Long-term use of concrete materials in math instruction raises math achievement, and teaching with diagrams and pictures seems to be just as successful as teaching with symbols (Sowell, 1989). Additionally, technology can significantly improve mathematics active learning, increasing student motivation and engagement (López-Caudana et al., 2020). But in order to create a synergistic relationship between teachers and technology and enhance mathematics learning outcomes, proper teacher training is crucial to the success of technology integration (López-Caudana et al., 2020).

Students' understanding and passion for the subject can also be improved by incorporating differentiated instruction, collaborative learning techniques, and real-world applications (Gallagher et al., 2020). According to the findings, math performance can be raised by using instructional strategies that encourage positive student participation in a given subject (Oginni et al., 2021). Instructors should always pose real-world problems to their students that they can resolve with the help of the resources at their disposal (Nafiah et al., 2019). Teachers should also offer activities that help students learn how to collaborate and share knowledge with one another (Dimatacot & Parangat, 2022). A thorough and cooperative strategy that includes curriculum reform, teacher preparation, resource distribution, and community involvement is necessary to overcome these obstacles. Teachers can foster deeper engagement, improve critical thinking and problem-solving abilities, and ultimately help students reach their full mathematical potential by embracing innovative pedagogical strategies, utilizing technology, and creating a positive learning environment (Serin, 2023). Despite knowing that mathematics is essential to advancing in both their academic and personal lives, students display a casual attitude toward it (Nandwa et al., 2015). Thus, to make mathematics more approachable and practical, educators and students must work together (Nandwa et al., 2015). Teachers, students, and instructional resources have a three-way relationship that must be taken into consideration in order to improve mathematics achievement (Nandwa et al., 2015). Society views mathematics as the cornerstone of scientific and technological knowledge, which is essential to the social and economic advancement of a country. The importance of mathematics education is becoming more widely acknowledged, and there are many chances for interdisciplinary research in this field (Uveruveh & Perekeme, 1970).

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