

## Effective Pedagogical Approaches for Enhancing Students' Mathematics Achievement and Proficiency

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**ABSTRACT:** Despite various measures implemented by different stakeholders to enhance the teaching and learning of mathematics in Tanzania, the pass rate for students in the Form Four national examinations has remained below 25% for over fifteen consecutive years. This ongoing widespread failure in mathematics is probably linked to several factors, including teaching methods used by educators, attitudes of students and teachers towards the subject, political influences, community perspectives, and the overall school environment surrounding the learners. This paper explores the most effective strategies that teachers and other stakeholders can adopt to make mathematics lessons more engaging and promote positive attitudes among students, thereby unlocking their potential in the subject. These strategies were initially identified through a scoping review of existing scholarly works sourced from various databases and then tested for practicality and relevance in selected secondary schools in Tanzania by sharing them with mathematics teachers and students. Additionally, a group of twenty (20) pre-service mathematics teacher trainees, enrolled at a university and volunteering to support mathematics teaching in the selected schools, implemented these strategies. The teaching support programme was conducted on weekends, during vacations, or on days when the pre-service teachers had

fewer classes at the university. On average, each volunteer dedicated four hours per week to visiting schools and supporting the mathematics teaching and learning process. Feedback from teachers and students, students' scores before and after the intervention, and lessons learnt from the programme helped to confirm the effectiveness of the proposed strategies in unlocking students' potential in mathematics.

**Keywords:** *Scoping Review, Effective Teaching Strategies, Students' Mathematics Potential, Mathematics Teaching Support Programme.*

## 1. Introduction

Tanzania has faced a persistent and significant failure in mathematics for over fifteen (15) years, as shown by students' pass rates in national examinations. Despite numerous efforts so far, the pass rate in form four national mathematics examinations remains low. The National Examinations Council of Tanzania (NECTA) reports from 2008 to 2024 reveal a consistent pattern of widespread failure in Mathematics, with nearly 75% of all students sitting for the National Form Four Mathematics examinations failing the subject. NECTA reports also indicate that students' performance in mathematics varies considerably compared to their results in other subjects. For example, during the 2022 examinations, the pass rate in Mathematics was 20.08%, while those same students achieved pass rates of 66.1%, 95.59%, and 67.84% in Geography, Kiswahili, and Biology, respectively (NECTA report, 2022).

The 2022 Candidates' Item Response Analysis report on the Certificate of Secondary Education Examination (CSEE) revealed that, of the 14 questions in the Basic Mathematics exam, only one, covering Units, Rates, and Variation, had a pass rate of 32.7%. The other 13 questions, which were drawn from 26 Mathematics topics, showed pass rates below 30%, ranging from 4.2% to 26.1%. The 2020 report indicated that only five topics Statistics, Sequence and Series, Accounts, Ratio, Profit and Loss, and Rates and Variations had acceptable average scores, while the remaining topics performed poorly or very poorly. Similarly, in CSEE 2019, only three topics, Statistics, Circles, and Rates and Variations, achieved acceptable average performance. Overall, no topic has performed well over these years. The

trend in students' Mathematics performance from 2008 to 2023 is illustrated in Figure 1.

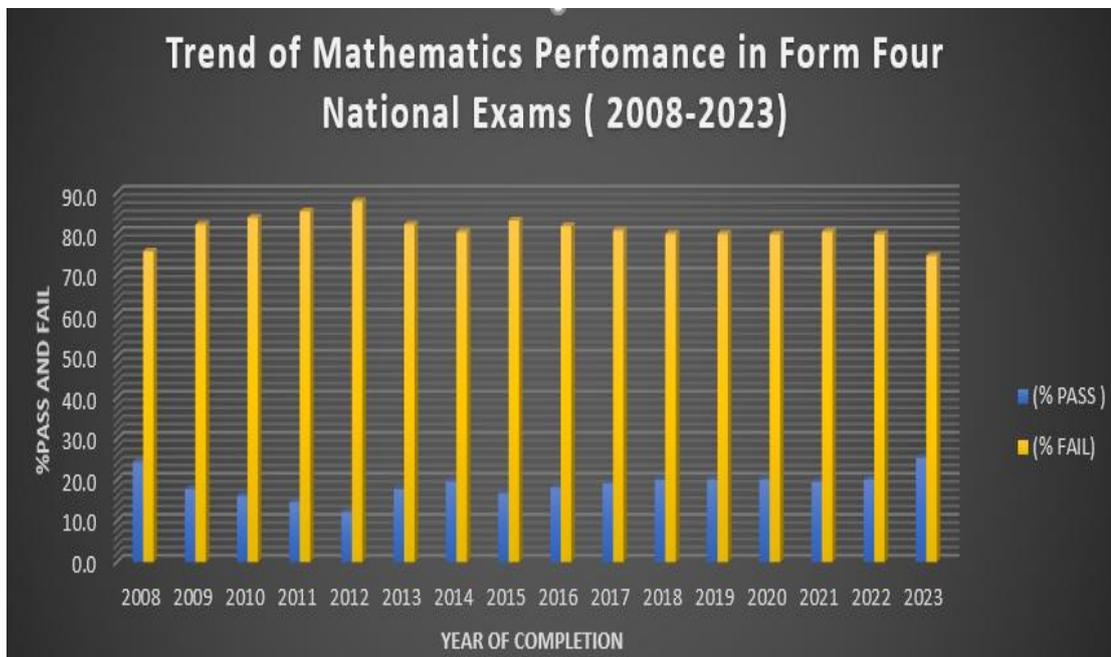


Figure 1: Mathematics performance Trend in Tanzanian secondary schools

Although poor performance in Mathematics is more noticeable at the secondary level than at primary level, many scholars still believe that the observed difference mainly resulted from the nature of the assessment rather than students' understanding. Unlike the Form Two and Form Four exams, where students are required to solve questions and show all necessary steps leading to the final solution, primary school maths exams asked pupils to select the most correct answer from a list of options provided for each question. These multiple-choice questions encourage guessing and do not help pupils develop critical thinking, thinking and problem-solving skills as required by the curriculum. The performance gap between primary and secondary schools became clear after the introduction of multiple-choice exams in 2015, as shown in Figure 2. However, the 2024 primary school mathematics exam format, recently announced by the Ministry of Education, now requires students to solve problems rather than simply select an answer from a set of options. Future studies will find out whether this performance gap was due to nature of questions in these two levels.

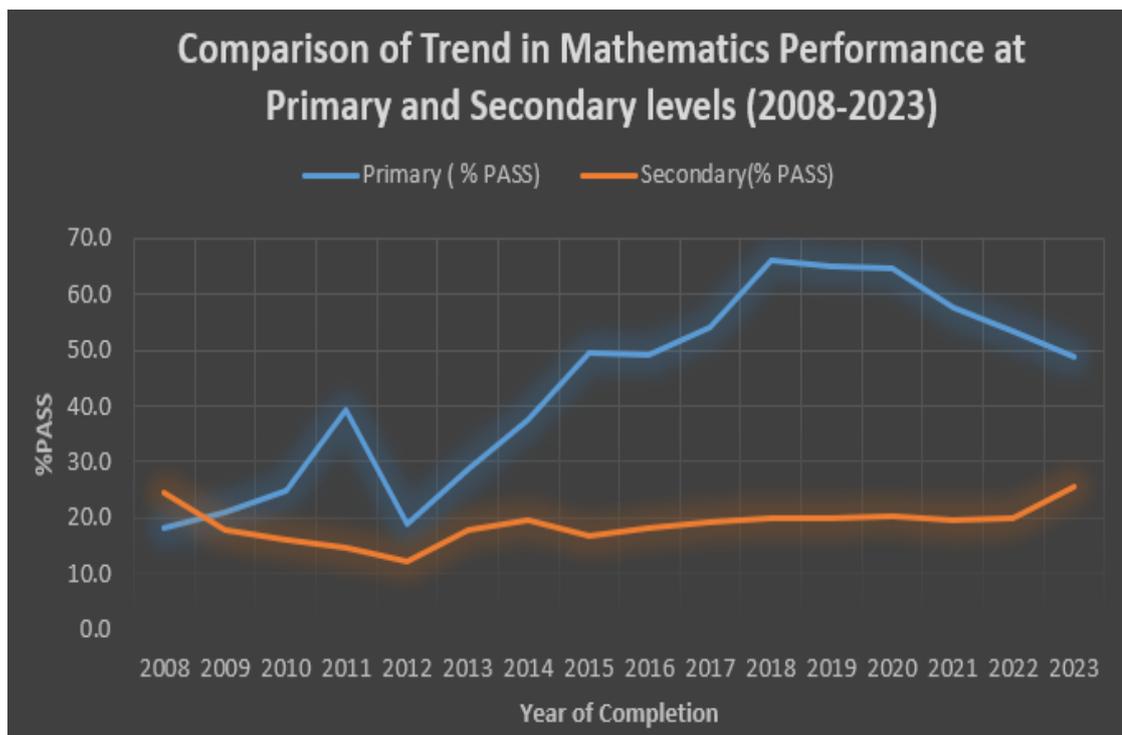


Figure 2 Comparison of primary and secondary schools' mathematics performance trend in Tanzania

Persistent failures in mathematics clearly show that most students do not fully understand the material covered in class. If they do, it is often only superficial knowledge rather than a deep, meaningful understanding of the concepts. This widespread failure raises serious concerns about the quality of mathematics education in the country and threatens the realisation of the industrialisation policy. Since mathematical concepts are crucial across all other science subjects and a pass in mathematics is among the key criteria for enrolling in most science programmes at higher learning institutions in and outside Tanzania (TCU and NACTE Admission Guidebooks 2023/2024), this significant failure automatically hampers many students from becoming scientists or pursuing science-related careers. Consequently, progress towards achieving the Tanzania industrialisation policy will also be hindered without enough skilled professionals from the science fields. Indeed, science and technology are the main pillars of any strategy to advance industrialisation.

As highlighted by previous scholars, poor performance in mathematics mainly results from ineffective teaching strategies and a general sense of anxiety, phobia, or negative attitude towards the subject. (Ramirez) Although various interventions have

been implemented and numerous studies conducted to identify the causes of poor performance in mathematics and explore potential solutions, the issue remains, as the percentage of students failing the subject stays essentially unchanged. Therefore, this study aims to explore, through previous research, insights from mathematics teachers and students themselves on strategies that can effectively help students succeed in mathematics. The study reviews several academic papers on mathematics teaching methods to identify knowledge gaps, clarify concepts, and verify the relevance of current teaching practices used by mathematics educators. In conclusion, this paper presents findings from the Mathematics Teaching Support Programme, an intervention designed and implemented to assess the effectiveness of proposed strategies in a school setting.

Generally, this paper addresses three research questions:

- i. i. What does the literature say about the effective strategies, methods, or techniques for teaching and learning mathematics?
- ii. How do teachers' and students' perceptions match the documented and reviewed teaching and learning strategies, especially in the Tanzanian context?
- iii. What challenges are involved in implementing the suggested strategies in teaching and learning mathematics?
- iv. What are the possible interventions for addressing the massive failure problem in mathematics subjects?

## **2. Methodology**

This study employed three methodological approaches. The first was a scoping review of previously published studies that helped identify effective mathematics teaching and learning strategies across various classroom practices, settings, and levels. Unlike systematic reviews and meta-analyses, the primary aim of scoping reviews is to describe the existing literature and other sources of information, encompassing findings from a range of different study designs and methods. The results of a scoping review often focus on the scope of content identified, and quantitative assessment is usually limited to a tally of sources reporting a specific

issue or recommendation. (Hwang et al., 2023; Murphy & Ingram, 2023; Sucharew & Macaluso, 2019).

A scoping review was carried out to identify effective teaching and learning strategies that can enhance students' potential in Mathematics. The review involved several stages: refining the review question, selecting and identifying relevant studies, charting the collected data, and summarising the findings. The PICO (Population, Intervention, Comparison/Context, and Outcome) framework was utilised to conduct a comprehensive literature review of articles related to keywords entered into the Mendeley search bar. The main search terms included mathematics teaching strategies, techniques, methods, and classroom practices aimed at unlocking students' potential in Mathematics.

In this study, the population of interest was secondary school students and their Mathematics teachers. 'Intervention' refers to any teaching strategy, method, technique, or approach used by Mathematics teachers within a specific class or group of students. 'Comparison' was not the primary focus of this study, but where applicable, students' achievements before and after applying a particular teaching method, technique, or strategy were compared to assess its impact on learning. The 'outcome' was defined as students' performance in Mathematics in pre- and post-tests.

For the scoping review, the researcher searched several databases, including ERIC, Web of Science, Google Scholar, SCOPUS, and Springer. A total of 609 articles were retrieved, of which 151 met the inclusion criteria. The Boolean operators "OR" and "AND" were used to connect related articles. To identify relevant studies, well-defined exclusion and inclusion criteria were established in Covidence before extraction. The screening and data extraction processes were carried out using Covidence software, which supports single-reviewer extractions. Only recent studies published in English were included, within a time frame of the last 10 years (2014–2024). The PRISMA diagram below summarises the selection and screening process. Data extraction and analysis were conducted to develop a summary of effective strategies for unlocking students' potential in mathematics, as presented in section 3.1.

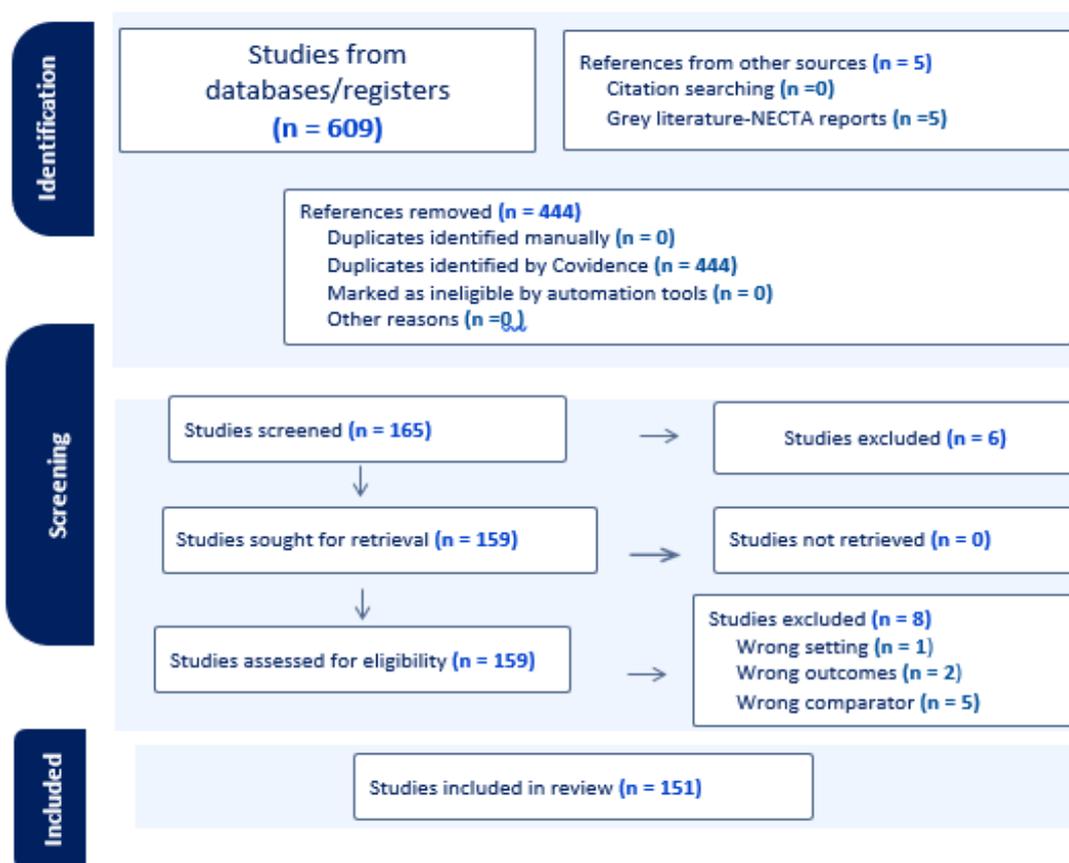


Figure 3: Prisma Flow Diagram

The second methodological approach was a sample survey that allowed the researcher to gather perceptions from mathematics teachers and students regarding the practicality of the reviewed strategies in Tanzanian classrooms or contexts. Responses from both teachers and students are summarised in sections 3.2.1 and 3.2.2, respectively. The third approach involved a case study, in which seven secondary schools participated in a Mathematics Teaching Support Programme that implemented the strategies identified from the scoping review within classroom settings. The researcher recruited twenty (20) pre-service maths teacher trainees enrolled at a university who voluntarily joined this teaching support programme. Before implementation, they were trained to apply the proposed strategies in classrooms, after which they were assigned to nearby schools to teach Form One and Form Three students. The selected schools faced a shortage of mathematics teachers responsible for all students from Year 1 to Year 4. These schools were also located close to the volunteers' university, which helped reduce transportation costs. At the end of each cycle programme, volunteers received a certificate of appreciation for

their community service. Lessons learnt from this programme are summarised in section 3.3.

### **3. Results and Discussion**

#### **3.1 Results from scoping review: Suggested strategies for unlocking potential students in Math**

Given that poor performance in mathematics impacts countries and educational systems worldwide, numerous studies have been conducted to address this issue. The scoping review of these studies indicates that the main factors contributing to students' poor performance in mathematics include students' and teachers' negative attitudes towards the subject, high teachers' workload, insufficient teacher competence in both content and pedagogy, poor classroom practices, lack of adequate teaching and learning resources, limited understanding of the connection between mathematics and real-life situations, and poor recruitment and preparation of mathematics teachers for teaching positions. (Chand et al., 2021; Estonanto, 2018; Fokuo et al., 2022; Iddrisu et al., 2023; Sule, 2017). Attitude relates to how someone thinks and feels about something. Previous scholars have noted that developing a negative attitude towards mathematics is a gradual process and does not happen suddenly (Akinsola & Olowojaiye, 2021; Davadas & Lay, 2020; Shah et al., 2023; Syamsuri & Bahtiar, 2023; Waheed & Mohamed, 2011; Wakhata et al., 2022; Wen & Dubé, 2022; Yasar, 2016). When children begin school, they are usually free from fear and typically have a positive attitude towards learning, along with a strong motivation for education. However, depending on the school environment and early educational experiences, children may start to lose motivation and gradually develop a negative attitude towards learning and school. In mathematics, students often develop fear, anxiety, and negative attitudes when they encounter repeated failures in classwork and assessments or when they struggle to connect what they learn in class with their life experiences. As Silver and Libertus (2022) report, negative community attitudes and beliefs about mathematics can negatively influence students' performance, as they often shape how mathematics is taught in schools and how it is perceived in society.

The National Examination Council of Tanzania regularly produces item-response analysis reports to provide feedback to students, teachers, policymakers, and other education stakeholders on candidates' performance in each subject. These reports are generated annually for all subjects and are based on observations from marking students' examination scripts. They offer a detailed explanation of how students approached each question, clarify what was expected of students, include samples of both the best and the poorest student answers or solutions, and give recommendations to improve students' performance.

The 2021 report on mathematics subjects highlighted that the main factors contributing to average and poor performance in Mathematics included students' failure to apply correct formulae, rules, theorems, properties and procedures; to formulate expressions, inequalities and equations from word problems; to perform accurate mathematical operations; and to draw diagrams and graphs, as well as interpret figures correctly. The report suggests various teaching techniques to enhance students' performance, such as using teaching aids and real objects, which can help students relate classroom concepts to real-world situations. Unfortunately, some teachers do not dedicate enough time to reviewing these reports and implementing the recommendations. To prevent similar issues in the future, mathematics teachers should plan and deliver lessons that foster a deep understanding of concepts and help students develop these essential skills.

A meta-analysis explored the impact of cooperative learning techniques on students' mathematics achievement in Turkey, reviewing 47 articles. Essentially, a cooperative learning strategy allows students to engage in face-to-face communication while working collaboratively to complete a task and reach a specific learning goal. In this approach, learning results from each group member's contributions, with minimal support and intervention from teachers. However, for this method to succeed, teachers should assist students in developing their interpersonal and intrapersonal skills to promote productive group discussions. Mathematics teachers are also expected to prepare adequate resources to guide students during these discussions. The previous study's findings indicated that cooperative learning techniques improve mathematics achievement, with the effect size remaining consistent across elementary, middle, and high school levels, as well as the undergraduate level.

Cooperative learning can also be promoted through peer tutoring, which includes various methods that allow learners to work together in pairs or small groups to provide each other with explicit teaching support. Studies by Alegre et al. (2020) and Martí Arnándiz et al. (2022) emphasise the importance of peer tutoring in mathematics instruction and learning. Peer tutoring may involve cross-age tutoring, peer-assisted learning, reciprocal peer tutoring, or a gallery walk. In cross-age tutoring, a teacher can assign an older learner (e.g., a higher class level) to act as a tutor and partner with a younger tutee or tutees (lower class levels), guiding them in solving mathematical problems. Alternatively, a teacher can organise peer-assisted learning, a structured approach in mathematics where students proficient in the subject are allocated 25–35-minute sessions, two or three times a week, to help their peers understand specific mathematical concepts. Similarly, a teacher might implement reciprocal peer tutoring, where learners alternate roles between tutor and tutee. This method is particularly effective as it keeps all students engaged and motivated to prepare their presentations for peers. These presentations of peer tutoring tasks can take the form of gallery walks, activity circuses, or learning stations. Overall, peer teaching or peer tutoring can be highly beneficial for both students and teachers, especially in schools with limited or no mathematics teachers.

Another study proposed the use of problem-solving strategies and scientific approaches in developing students' higher-order thinking skills, such as communication, creativity, problem solving, and mathematical reasoning skills. Teaching through the problem-solving approach in mathematics means that students are supported in learning through problems, questions, or challenging tasks that are often presented in written form and lack clear rules or formulas for solving them. Conversely, scientific approaches in mathematics focus on helping students observe, question, experiment, associate, and communicate mathematical ideas. The study concluded that problem-solving strategies are more effective than scientific approaches in enhancing students' abilities in mathematical communication, creativity, and reasoning.

Studies by Tokac et al. (2019), Lin & Cheng (2022), and Mavridis et al. (2017) examined the effects of game-based learning on students' mathematics achievement. Tokac et al. (2019) conducted a meta-analysis that compiled data from 860 studies on

the effects of computer games on student mathematics achievement. These studies were found in various databases, including ERIC, PsycINFO, Wilson, Google Scholar, JSTOR, and ISI Web of Science, and they included empirical studies, peer-reviewed journals, book chapters, theses and dissertations, and conference papers. Overall, the findings indicated that video games are a slightly effective instructional strategy for teaching mathematics across Pre-K- 12th grade levels. The use of games benefits visual, audio, and kinesthetic learners who learn best by seeing and performing various tasks during the lesson.

Another scholar investigated the impact of metacognitive strategies and self-regulating processes on learners' achievement in solving maths word problems. The researcher specifically analysed how linguistic factors and the number of steps and arithmetic operations learners need to perform affect the process of solving these problems. The study involved a sample of 233 students from two urban schools in Kosovo. Nearly half of these students received metacognitive instruction. In contrast, the other half were placed in control classes where they completed tasks without specific guidance, relying solely on traditional methods and textbooks. All learners were tested on maths word problems twice, before and after the intervention. The study found a statistically significant difference between the pretest and posttest results for both student groups. It concluded that metacognitive strategies and self-regulatory processes used to control actions, reason, and reflect are key resources influencing success in solving maths word problems.

Additionally, Mazana et al. (2018) noted that students' limited knowledge of effective learning and examination strategies or techniques is a factor in ongoing failure in mathematics. Their study found that most students lack strategies such as speed and accuracy, which restrict their ability to understand mathematical concepts taught in class and to perform well on maths exams. This suggests that, in most maths lessons, students adopt surface learning approaches that do not foster a meaningful understanding of the concepts, and they may fail because of particular study habits. Their research indicates that both teachers and students should collaborate to design and develop the most effective study techniques to promote a deep understanding of maths lessons. Mathematics teachers must help their students achieve a thorough conceptual understanding. To confirm that students have truly

grasped a concept, they should be able to demonstrate all the detailed steps in a process, explain why those steps occur, and connect the process to related concepts. A deep mastery of concepts will also enable students to develop the mathematical skills necessary for progression and innovation in STEM-related fields. Teachers and parents should also support children in acquiring the necessary study skills (Onoshakpokaiye, 2021) that can aid in retaining information and, ultimately, improve their maths performance.

A need to establish specific interventions that reduce math anxiety and/or lessen its negative impact on achievement was also suggested by Ramirez, Shaw, and Maloney (2018). These researchers reviewed previous studies examining the connection between math anxiety and achievement, factors that can cause math anxiety, student characteristics that may increase their vulnerability to it, and strategies educators can use to address math anxiety. The studies indicated that math anxiety can originate from poor math skills, genetic predispositions, or socio-environmental factors such as negative experiences in maths classes, home environments related to maths, and how students interpret their past maths experiences and the outcomes of their problem-solving efforts. The findings suggest that teachers should implement various strategies to help students develop positive self-concepts and foster a strong, optimistic attitude towards the subject.

Furthermore, research indicates that teachers' attitudes and beliefs about mathematics such as its practicality, preferred teaching and learning methods, perceived difficulty or ease, and gender differences in achievement shape how they view the subject. This, in turn, significantly influences students' performance (Peteros et al., 2019). Overall, the literature confirms that both students' and teachers' attitudes towards school and learning are key predictors of students' academic success. A study by Marpa (2019b) highlighted that teachers' behaviours can increase students' maths anxiety if they impose excessive pressure. Such pressure appears to be a common challenge faced by students in their daily learning, often caused by teachers and family members who hold very high expectations for students to succeed in mathematics. Competitive pressure from peers and friends also tends to heighten students' anxiety when learning mathematics.

While encouraging students to work hard, the study found that overemphasising excellent exam results can cause worries, fears, and anxiety, potentially leading to emotional or psychological issues. The research urges everyone to develop effective strategies to manage and reduce the pressure associated with high performance. Unfortunately, some mathematics teachers are excessively strict, creating a fear of asking questions when students do not understand or of volunteering to answer. To address this issue, mathematics teachers should adopt a variety of techniques that make students feel more comfortable during lessons, such as using interactive or student-centred teaching approaches, providing differentiated tasks, offering personalised, constructive, and timely feedback, motivating or rewarding high achievers and the most improved students, encouraging low achievers, and focusing more on students' problem-solving abilities rather than solely on achieving good grades.

Another study (Spooner et al., 2019) emphasised the need for teachers to help students learn both a progression of foundational skills (e.g., early numeracy) and how to apply these skills within the content of their assigned grade levels. These researchers noted that students need instruction that focuses on foundational mathematics skills, such as number sense, while applying them to higher levels. The issue of imparting numeracy skills to children was also emphasised by Seitz & Weinert (2022) and Tout (n.d.), who described numeracy as a critical awareness that bridges mathematics and the real world, with all its diversity. This researcher suggested that, for students to gain numeracy skills, teachers should use a problem-solving, investigative, open-ended approach when teaching and should use authentic texts and real situations to connect mathematics to the real world. Different authors have emphasised a strategy for teaching mathematics that involves designing lessons to help students connect classroom concepts with real-life experiences. This recommendation was proposed by Altay et al. (2017), Arthur et al. (2018), and Özgeldi & Osmanoglu (2017), who call for mathematics teachers to design and implement deeper teaching strategies that enable students to establish meaningful connections between classroom mathematics and life experiences.

Several scholars have mentioned the use of technology in teaching and learning mathematics as a possible means of improving students' achievements (Abramovich

et al., 2019a; Çavuş & Deniz, 2022; Çetinkaya, 2019; Dewi & Maulida, 2023; Haas et al., 2022). As pointed by (Abramovich et al., 2019) Curiosity and motivation can also be supported by the use of digital tools as instruments of action learning. (Çetinkaya, 2019) Found that the use of the mobile application in teaching mathematics to Grade 8 students somehow helped to enhance students' achievement and learning. These scholars therefore recommended that the administrator enforce and require the use of the mobile application to maximise learning, and that teachers equip their learners with the latest technological skills so that they may compete globally. As explained by (Marpa, 2020). Integration of ICT in mathematics is not merely using computers for typing and printing questions, searching for and delivering lessons via PowerPoint, but instead using ICT to teach various topics in mathematics and to encourage students to use technology in their mathematics learning.

The use of effective assessment strategies is also key to improving students' math grades. Mathematics teachers should have a high ability to assess their students before, during and after classroom teaching, which is an important predictor of mathematics achievement (Alfaro & Joutsenlahti, 2020). Assessment in mathematics should focus more on authentic assessment rather than on rote learning, as in multiple-item tests or passive test-taking. Authentic assessment focuses on making students demonstrate the various skills and concepts they have learned in class and explain when it would be appropriate to use those facts in mathematics computations or in solving a real-life problem.(Çetinkaya, 2019; Dewi & Maulida, 2023; Haas et al., 2022)

### **3.2 Results from Survey: Teachers' and students' feedback**

#### **3.2.1 Mathematics teachers' perceptions of the effective strategies for teaching and learning mathematics**

The reviewed strategies were shared with some secondary school mathematics teachers from selected schools in the Kilimanjaro region to verify their relevance and practicality in Tanzanian classroom settings. A total of 18 mathematics teachers participated in the online survey and provided their opinions. Overall, we observed a weak link between teachers' perceptions of the applicability of certain teaching

strategies and the findings from the scoping review. While the literature links students' poor performance to classroom practices often managed or guided by teachers, most teachers (67%) believe that poor performance in mathematics is mainly due to students' negative attitudes towards the subject. Consequently, the primary recommendation from teachers for improving performance was to deliver motivational speeches to students as frequently as possible, particularly at the start of each mathematics lesson. Their second recommendation was to train both students and teachers on the role and application of mathematics in real-life situations, aiming to enhance their appreciation of it. Mathematics teachers also called for students to be more committed to practising how to solve mathematics and to focus more on their studies. Finally, these teachers expressed concern about low teaching morale, caused by their large workloads and burnout, which is not reflected in students' performance or their monthly salaries. They requested the government to prepare and employ more mathematics teachers so that they can help ease the current situation. These teachers also asked for improved teaching and learning conditions, such as an increase in books, computers, and projectors, which will make their lessons more engaging and learner-centred.

### **3.2.2 Students' feedback on effective strategies for teaching and learning mathematics**

We visited seven (7) secondary schools in the Kilimanjaro region, to give them motivational talks on the relevance of mathematics in their real life, possible career paths related to mathematics subject and advise them on the effective strategies that they can use to excel in mathematics. During these visits, we also administered a questionnaire to a sample of 248 students with the aim of obtaining their honest opinions as to why many students failed mathematics and possible ways of addressing the problem. While the majority of mathematics teachers believed that the major reason for the persistent failure in mathematics is the negative attitude of students toward the subject, most of the students (79%) feel that the harsh treatment from their teachers is the primary reason for the massive failure since it demoralizes many students and leads to hatred of not only the subject but also the math teachers. This finding compares with what was presented by (Furner, 2021), who found that some mathematics teachers tend to become too grumpy and angry when students fail

to work on a given question, and this teacher's anger creates more fear in students to ask for clarification or further interact with their teacher. Such situation results in more students' failures in the consequent classroom tasks and exams.

Additionally, many students (73%) raised a concern about the teaching methodologies that are used by mathematics teachers in class and admitted that many students do not understand at all the concepts that are presented by their math teachers. The issue of focusing on students' conceptual understanding was also stressed by (Amirullah & Iksan, 2018), who considered an effective teacher as the who uses various methods according to the learning culture and student level to ensure that students achieve the conceptual understanding and the learning objectives. Other major concerns that were mentioned by students included the scarcity of mathematics teachers, lack of career guidance for students and inadequate language skills especially in interpreting word problems in math. As reported by (Furner, 2017), it is a school's obligation to see that their students value and feel confident in their ability to do math because ultimately a child's life and all decisions they will make and career choices may be highly influenced by their disposition toward mathematics. A summary of all students' responses on the causes of poor performance in Math is presented in Figure 3.

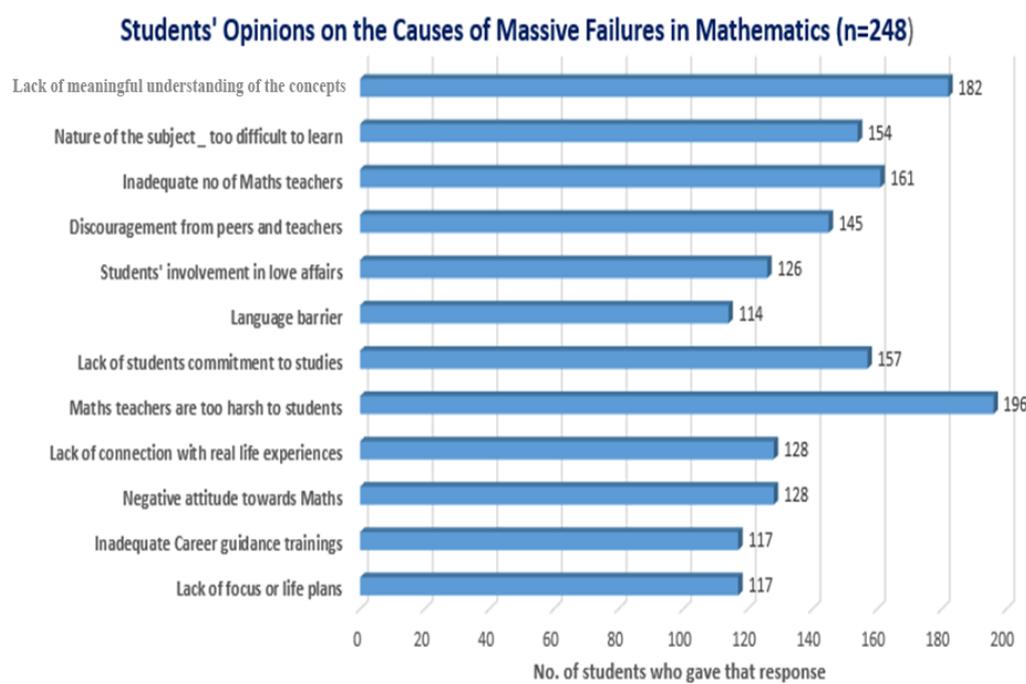


Figure 4: Why Massive failures in Mathematics? Source: Field Data

As indicated in figure 3, majority of students (79%) who participated in the study mentioned the harsh behavior of mathematics teachers as the major reason for the failures. We also noticed that many students (73%) confessed that they do not understand what they are taught in class. This lack of a deep, meaningful understanding of the concepts covered in class is one of the reasons students' memory retention is poor. We therefore recommend that the teachers take into consideration all issues raised by students in Figure 3 and design their lessons in a manner that students will be learning more meaningfully rather than having just rote learning. A shallow understanding of the concepts is also reflected in the item analysis reports prepared by the National Examination Council (NECTA) after the marking of national examinations. These reports show that most students do not understand the questions and, as a result, give responses that differ significantly from the examiner's expectations (NECTA, 2021).

### **3.3 Evidence from Maths Teaching Support Programme**

To address the shortage of mathematics teachers, the unit of Mathematics and Statistics initiated a Mathematics teaching support programme in which pre-service mathematics teachers used their free time to visit nearby schools and support the teaching process voluntarily. Approximately 30 students enrolled in mathematics-related programmes at MWECAU during the study period volunteered for this support programme and were assigned a school where they would work. Before starting the programme, we visited the schools to learn their specific needs and plan activities that suit each school's needs. On the first visit to each school, students were trained to develop positive attitudes toward maths and its application in real-life situations.

To support teaching in nearby schools, the Maths Teaching Support Programme provided us with a space to practice effective strategies gathered from the scoping review exercises, to assess their relevance in Tanzanian school settings. These volunteers were trained in the proposed strategies and asked to apply them in their day-to-day teaching for 3 months. Among other issues, these volunteers were instructed to include the aspect of real-life application of every topic or subtopic that they teach and allow their students to ask as many questions as possible. The

volunteers were also encouraged to use positive rewards rather than harsh punishments for students who score low grades on tests or exams. In each school, the volunteers established a mathematics club where students met to discuss several mathematical challenges and play games that promoted students' interest in mathematics.

To assess the effectiveness of the proposed teaching strategies, we administered mathematics exams (for form one and form three) before and after the Maths Teaching Support programme. The students' scores were analysed both descriptively and inferentially. Descriptive statistics were used to describe the characteristics of sample data, while a paired t-test was used to make inferences on students' performance before and after the implementation of the maths teaching support programme. For the case of inferential analysis, the paired t-test was performed to assess whether there was a significant difference in mean performance before and after the teaching support programme. Similar tests were administered to all form one and form three students before the commencement of the Teaching Support Programme and at the end of the programme. The class mean performance for all schools and all levels is presented in Table 1. The actual school names are hidden to maintain confidentiality.

Table 1: Pre and Post test mean scores for participating schools

SN	SCHOOL	PRE TEST _Classmeanscore	POST TEST Classmeanscore	CLASS LEVEL
1	A	9.38	26.04	1
2	B	13.69	16.16	1
3	C	11.00	25.68	1
4	D	17.23	23.90	1
5	E	9.67	20.59	1
6	F	10.42	23.67	1
7	G	15.40	20.92	1
8	A	16.84	17.12	3
9	B	11.70	19.26	3
10	C	16.71	17.69	3
11	D	9.49	22.12	3
12	E	10.02	18.40	3
13	F	9.97	19.00	3
14	G	16.96	24.84	3

Descriptive analysis of the dataset in Table 2 shows an improvement in class mean score of the post test as compared to the pre test in all participating schools and in both class levels (Form one and Form three). Descriptive analysis of the mean score before the teaching support programme (M=25.4979, SD = 6.43012) and after the teaching support programme (M=31.6493, SD =4.96197) indicates an increase of the mean score by almost 6 points after the teaching support programme.

Table 2: SPSS Output on Descriptive Analysis

Descriptive Statistics							
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
PRE TEST _Class means score	14	15.71	18.76	34.47	25.4979	6.43012	41.346
POST TEST Class means score	14	14.83	24.24	39.07	31.6493	4.96197	24.621
Valid N (listwise)	14						

Table 1: SPSS Output on Paired Samples Correlation

Paired Samples Correlation				
		N	Correlation	Sig.
Pair 1	PRE TEST _Classmeanscore & POST TESTClassmeanscore	14	-.173	.555

Table 2: SPSS Output on Paired t test results

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PRE TEST _Classmeanscore - POST TESTClassmeanscore	-6.15143	8.77403	2.34496	-11.21740	-1.08545	-2.623	13	.021

We also performed a two-sided test (Prob > |t|) with the null hypothesis that the mean difference between the paired test scores is zero and the alternative hypothesis that it

is not. The paired t-test also yielded a p-value of 0.021 as indicated in Table 3, which is lower than the standard significance level of 0.05; hence, we reject the null hypothesis and conclude that the mean difference between the two test scores was significantly different from zero.

Table 3: Measuring the effect size

Effect size based on mean comparison, unequal variances			
Obs per group:			
Group 1 = 14			
Group 2 = 14			
Effect Size	Estimate	[95% Conf. Interval]	
Cohen's <i>d</i>	1.071012	.2628209	1.860362
Hedges's <i>g</i>	1.039766	.2551535	1.806089
Satterthwaite's degrees of freedom = 24.4255			

We also used Cohen's *d* and Hedges' correction tests for correlated groups to evaluate the effect size of the mathematics teaching support intervention. The STATA output presented in table 5 summarises the results. Statistically, when Cohen's *d* value is less than or equal to 0.20, we conclude that the effect is small; that is, the independent variable has little influence on the dependent variable. When Cohen's *d* value is around 0.50, we conclude that the effect is medium, and when it is above 0.80, it implies the effect size is large. The results for this study show Cohen's *d* and Hedges' correction standardiser values of 1.071012 and 1.039766, respectively, both higher than 0.8, indicating that the teaching support programme had a significant effect size on students' performance. Therefore, by analysing the pre-test and post-test mean scores both descriptively and inferentially, we arrive at the same conclusion that there was a statistically significant difference between the pre-test and post-test scores; hence, the teaching support programme was effective in improving students' scores in Mathematics.

### 3.4 Challenges associated with the implementation of the suggested strategies in teaching and learning mathematics

The researcher conducted five different interview sessions with mathematics teachers, one from each visited school, to gather their opinions on what they think

might hinder their use of the proposed strategies in their daily teaching. All the teachers who participated in this survey indicated their willingness to apply these strategies, but they raised several concerns that might limit their use. Among their primary concerns was the heavy teaching workload, which left them too busy to prepare interactive and engaging lessons. For example, two-thirds of the schools that were involved in the Maths Teaching Support Programme had only one mathematics teacher who was supposed to handle all mathematics lessons from form one to form four. Another challenge was the availability of teaching and learning resources. Example one: the teacher said it is hard for him to use videos or make demonstrations on a computer in a school where there is not even a single computer or projector. When asked how often he integrated technology in his teaching, he responded:

*“...I really wish to use technology in my day-to-day teaching, but how can I do that without computers and a projector in a class of more than fifty students?....”*

Teachers were also concerned about the negative attitude of their students and the community at large toward mathematics, which affects their readiness to learn. In response to students' negative attitude, some schools advise weak students to select only a few subjects (a maximum of 4 out of 7 compulsory subjects) to concentrate on and attain the minimum qualification for the award of the form four certificate. In such situations, the most likely subject to be dropped is mathematics, since most students find it too difficult and do not understand precisely why they should learn certain mathematical concepts. One teacher commented as follows:

*“...Sometimes it is hard for a mathematics teacher to decide properly what to do. Sometimes, as a school, we discuss possible strategies to reduce the high failure rate in national examinations, and one is to reduce the number of subjects a poorly performing student can handle so that he/she does not fail. In such a scenario, poorly performing students are advised to drop some subjects and remain with only four that he/she can manage. In such a situation, the first subject to drop is mathematics!...”*

Another teacher said this about dropping mathematics to improve school performance.

*“ .....Last year I felt very bad. I had around 80 form four students, grouped in two different streams-arts and science. I was advised to teach only science students. So during Mathematics lesson, only science students were required to attend while Arts students were asked to go the library to study other subjects. In their national Form Four examination results, all science students passed mathematics, and all arts students failed the subject. I really felt bad. Let us allow all students to attend all classes...’*

Inadequate knowledge of both content and pedagogical skills to handle some mathematics topics was identified as a challenge in implementing the suggested strategies. Teachers identified gaps in their understanding of some topics. They added that if a teacher is not competent in a particular topic, it will also be hard for him/her to prepare a lesson that helps students gain a meaningful understanding of the concepts. They also said that during their time in teacher training colleges and universities, they did not have the opportunity to cover all the topics in the current secondary school mathematics syllabus due to time constraints and the nature of teacher training programmes. Hence, if a teacher trainee had a poor background at the secondary school level, the chances are few that this knowledge gap will be filled well at the college or university level. One of the interviewed teachers said:

*“...some topics are difficult and new to us. For example, when I was in teacher trainee college, I did not learn about Accounts or Computer packages for teaching mathematics. However, now that I am asked to integrate a computer into my teaching, I cannot manage it. Also, it is hard for me to teach the accounts topic...I always invite another teacher to help me teach that topic.....”*

Generally, teachers’ opinions show that the proposed strategies are very effective in unlocking students’ potential in mathematics, but there is a need to strengthen teachers’ capacity to implement them. They also suggest that students should be trained and helped to develop positive attitudes toward the subject, and guided in using mathematical concepts and ideas to solve real-life problems.

## 5. Conclusion, Recommendations and Future Work

The central intent of this article was to provide insight into practical strategies for unlocking students' potential in mathematics by drawing evidence from a scoping review and from the actual math teaching support programme conducted in selected secondary schools in the Kilimanjaro region. Feedback from mathematics teachers currently working full-time in secondary schools helped assess the relevance of the proposed strategies. Generally, the majority of teachers agreed that these strategies are practical and, if well implemented, may help to improve students' performance. However, these teachers raised concerns about implementation barriers, such as the availability of teaching and learning resources, especially when integrating ICT into mathematics teaching. The large workload, inadequate content and pedagogical skills, and poor student attitudes were other concerns raised by teachers in the field. However, most of them appreciated the use of the gallery walk technique, as it will help them to assist more students through peer teaching. To address the noted challenges, the researcher recommends more school- and cluster-based training for mathematics teachers on both content and pedagogical skills, especially teaching strategies that can be used in schools with an inadequate number of teachers. Feedback from the teaching support programme was very encouraging, calling for more volunteering programmes in universities and colleges whereby the pre service mathematics teachers trainees and other mathematics majors can be involved in supporting math teaching in schools where there are not enough full-time mathematics teachers. Finally, students' training should also focus primarily on the real-world applications of mathematical concepts and on possible career opportunities for mathematics majors to promote their interest in mathematics. The government should also ensure that there are enough mathematics teachers in all schools and that they have adequate teaching and learning resources. Future work may involve an experimental study to test the effectiveness of each proposed strategy in various classroom settings in Tanzania.

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