



Effective classroom practices for unlocking student's potentials in mathematics

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ABSTRACT

Despite several measures that have been employed by different stakeholders to improve the teaching and learning of mathematics subject in Tanzania, the student's pass rate in form four national examinations has been less than 25% for more than ten (10) consecutive years now. This persistent massive failure in mathematics can be highly associated with teaching strategies that are used by teachers when delivering their lessons, student's attitudes toward the subject and the general school/learning environments that surround the students. This paper analyses the effective strategies that can be employed by teachers and other stakeholders to make mathematics lessons more meaningful and help students develop strong positive attitudes toward the subject, hence unlocking their potential in mathematics. These strategies were first compiled from a scoping review of previous scholarly works and then shared with mathematics teachers and students in selected secondary schools in the Kilimanjaro region of Tanzania to assess the practicability and relevance of the proposed strategies in daily teaching and learning processes. Data from Teachers were collected through online survey and for students we used focus group discussions and questionnaires. The suggested strategies were applied by Mwenge Catholic University students who participated in the volunteering programme of teaching mathematics subject in the selected schools during the Teaching Support Programme. Generally teacher's and student's feedback and the lessons learned from the Teaching Support Programme confirm the effectiveness of the proposed strategies. So if they are properly used, can help to unlock the students' potentials in mathematics and improve their performance.

Keywords: Scoping review, effective teaching strategies, mathematics potentials, teaching support program.

INTRODUCTION

Tanzania has been experiencing a persistent massive failure in mathematics for more than ten years, as evidenced by the student's pass rates on national examinations. Despite several interventions that have been made thus far, the pass rate in form four national mathematics examinations is still discouraging. The National

Examinations Council of Tanzania (NECTA) reports from 2008 to 2020 indicate a persistent mass failure in Mathematics such that more than 75% of all students who sat for the National Form Four Mathematics examinations in the past 10 years failed the subject. The NECTA reports also indicate that student's performance in

mathematics differs so much from the performance of the same students in other subjects, such as Kiswahili and chemistry, where the pass rates were 91% and 77%, respectively, just to mention few (NECTA, 2021).

In addition, the 2020 Candidate's Item Response Analysis Report on the Certificate of Secondary Education Examination (CSEE) shows that only five (5) out of fourteen (14) mathematics topics, namely, Statistics (50.3%), Sequence and Series (39.9%), Accounts, Ratio, Profit and Loss (39.6%) and Rates and Variations (31.5%), had average performance, while the rest had poor or very poor performance. A similar situation was noted in CSEE 2019, where only three topics, namely, statistics (53.4%), circles (53.4%) and rates and variations (33.9%), had average performance. Generally, none of the topics had good performance in either year (NECTA, 2021). Such poor and persistent massive failure in mathematics raises many concerns regarding the quality of mathematics education in the country and threatens the attainment of the industrialization policy.

Since mathematics cut across all other science subjects and a pass in mathematics is among the key criteria for joining most of the science combinations and programmes in higher learning institutions, this massive failure will automatically limit many students from becoming scientists or joining science-related careers. Progress toward the attainment of the Tanzania industrialization policy will also be derailed without enough and competent workforce from science fields. Indeed, science and technology are the major components of any strategy geared toward achieving the industrialization process. As pointed out by previous scholars, the dismal performance in mathematics can be primarily attributed to poor teaching strategies and the general anxiety, phobia or negative attitude toward the subject. (Ramirez et al., 2018; Rameli et al., 2016; Zakariya et al., 2015). Although several studies have been conducted to analyse the causes of poor performance in mathematics and their possible solution, the problem still seems to increase as the percentage of students who fail the subjects remains the same. (Lorenzen, 2017; Spooner et al., 2019).

This study aims to inquire from previous studies, mathematics teachers and students themselves about the possible strategies that can actually work properly in helping students excel in mathematics. This study also designed and implemented an intervention strategy (Mathematics Teaching Support Programme) that helped to test the effectiveness of some strategies in school settings. Conclusively, this paper maps several studies related to mathematics teaching strategies to identify knowledge gaps, clarify concepts and confirm the relevance of the teaching strategies that are

currently used by mathematics teachers in delivering their lessons.

Related work

A scoping review was conducted to examine the existing knowledge regarding the teaching strategies for mathematics subject from various perspectives. A total of 30 previous studies were surveyed to identify the best mathematics teaching strategies as well as their effectiveness. The reviewed articles and reports were published between 2017 and 2021 and can be accessed through Google Scholar and NECTA websites. From this review, we identified twelve (12) teaching strategies that were confirmed by previous scholars to be effective in teaching and learning mathematics subjects. As mentioned in section introduction, these strategies were tested in classroom or school settings to assess their effectiveness, and the findings are summarized in section results and discussion.

Since the problem of poor performance in mathematics cuts across different countries and levels of education, many studies have been performed to address it. The meta-analysis of those studies shows that the major factors for students' poor performance in mathematics are the students' and teachers' negative attitude toward the subject, large teacher's workload, inadequate teacher's competence in both content and pedagogy, poor classroom practices, inadequate teaching and learning resources, inadequate knowledge of the linkage between mathematics and real life experiences and poor recruitment and preparation of mathematics teachers for a teaching job. Attitude refers to a way someone thinks and feels about something (Zeidmane et al., 2017; Northwest, 2017). Previous scholars have pointed out that developing a negative attitude toward mathematics is a process and does not occur abruptly! (Mata et al., 2012; Zeidmane et al., 2017). When children start schooling, they are usually free from any fear, and they generally have a positive attitude toward learning with self-motivation about schooling.

However, depending on the school orientation and their first schooling experience in their first days of schooling, children may start losing motivation to study and slowly develop a negative attitude toward learning and school. In mathematics, students start to develop fear, anxiety and negative attitudes when they experience consecutive failures in class work and assessment or when they fail to relate what they learn in class with their life experiences. As reported, negative community attitudes and beliefs about math also have a negative impact on students' performance, as they often affect how mathematics is taught in schools (Webel et al., 2019; Mazana et al., 2019).

There are several reasons for massive failures in mathematics in Tanzania. However, the authors of this study believe that effective teaching strategies can help to ease the situation by addressing most of the challenges and improve student's performance. Therefore, this scoping review is intended to gather information from various scholars on effective strategies for teaching mathematics as reported by different experts from different classroom settings.

Scoping review of the proposed strategies:

The National Examination Council of Tanzania (ECT) has a tendency to prepare candidate's item response analysis reports to give feedback to students, teachers, policy makers and all other education stakeholders about the candidate's performance in each subject. This report is in preparation every year and for all subjects and is written based on what was observed during the marking of student's examination scripts. This report gives a detailed explanation of how student's attempted each question that was asked, clarification of what was expected from student's, samples of both the best answer and the poorest answer or solution that was given by student's and recommendations for improving students' performance.

For example, the 2021 report for mathematics subject pointed out that the major factors that contributed to average and weak performance were the candidates' failure to apply correct formula, rules, theorems, properties and procedures; formulate expressions, inequalities and equations from word problems; perform correct mathematical operations; and draw diagrams and graphs as well as interpret figures correctly (NECTA, 2021). This report recommends several teaching techniques for improving students' performance in mathematics, such as the use of teaching aids and real objects, which will help students link the concepts covered in class with the real world. Unfortunately, the majority of teachers do not invest enough time to go through these reports and implement the given recommendations. To avoid similar mistakes in the future, mathematics teachers are required to design and deliver their lessons in a manner that will promote a meaningful understanding of the concepts and enable students to gain such skills.

A meta-analysis examined the effect of cooperative learning techniques on students' mathematics achievement in Turkey by referring to 47 articles (Turgut et al., 2018). Basically, a cooperative learning strategy allows students to have face-to-face communication while working together as a team in performing a given task to achieve a certain learning target. In this approach, learning results from each group member's contribution with just little teacher support and interventions.

However, for this approach to work properly, the teacher is supposed to help students develop their interpersonal and intrapersonal intelligence to have productive groups. The findings from this study indicated that cooperative learning techniques increase mathematics achievement, and this effect is the same at the elementary, middle school, high school and undergraduate levels.

Co-operative learning can also be achieved through peer tutoring, which includes a range of approaches that enable learners to work together either in pairs or in small groups to provide each other with explicit teaching support. A study confirmed that peer tutoring in mathematics has similar academic benefits for both primary and secondary education (Mazana et al., 2019). Peer tutoring can take the form of 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, higher class levels) to take the tutoring role and be paired with a younger tutee or tutees (lower class levels) and guide them on how to address some mathematical problems.

Alternatively, a teacher can plan for peer-assisted learning, which is a structured approach for mathematics in which students who are good at math can be assigned sessions of 25–35 minutes two or three times a week to help their peers understand some mathematical concepts. Likewise, a teacher may plan for reciprocal peer tutoring in which learners alternate between the role of tutor and tutee. This is also a very good approach since it makes every student busy and committed to preparing what he/she will present to peers. Presentations of peer tutoring tasks can be in the form of gallery walks, activity circus or learning stations. Generally, peer teaching or peer tutoring can be of great help to both students and teachers, especially in schools that have no or few mathematics teachers.

Another study compared the role of problem-solving strategy and the use of scientific approaches in developing students' higher-order thinking skills, such as communication, creativity, problem solving, and mathematical reasoning skills (Tambunan, 2019). Teaching through the problem-solving approach in mathematics means that students are assisted in learning through problems, questions or challenging tasks that are often in word format and have no clear rules or formulas for arriving at the solution. On the other hand, scientific approaches in mathematics focus on helping students observe, question, experiment, associate, and communicate mathematical ideas. The findings from this study indicated

that problem-solving strategies are more effective than scientific approaches in developing students' abilities in mathematical communication, creativity and reasoning.

In addition, performed a meta-analysis to examine the effects of game-based learning on students' mathematics achievement (Tokac et al., 2019). These researchers analysed data from 860 studies that focused on the effects of computer games on student mathematics achievement. These studies were found in various databases, such as ERIC, Psyc INFO, Wilson, Google Scholar, JSTOR, and ISI Web of Science, and they were in the form of 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 lower levels.

The use of games benefits visual, audio and kinaesthetic learners who learn best by seeing and performing various tasks during the lesson. Other studies investigated the impact of metacognitive strategies and self-regulating processes in learner's achievement on solving math word problems (Mazana et al., 2019). It specifically analysed the impact of the linguistic factor and the number of steps and arithmetic operations that learners need to apply during the process of solving math word problems. Their study used a sample of 233 students from two urban schools in Kosovo. Almost half of these students were exposed to metacognitive instructions, while the other half were included in control classes in which they performed tasks without having been given any specific guidance, based exclusively on traditional methods and respective textbooks. All the learners were tested in math word problems twice, before the intervention and after it. The study found a statistically significant difference between the pre-test and the post-test results among the two groups of students. They concluded that metacognitive strategies and self-regulating processes that learners use to control their actions, to reason, and to reflect are some of the main resources that influence their success in solving a math word problem.

Additionally, mentioned the issue of student's limited knowledge on effective learning and examination strategies or techniques as a factor for persistent failure in mathematics (Mazana et al., 2019). Their study found that most students lack learning and examination strategies such as speed and accuracy, which limits their ability to understand mathematical concepts taught in class and to handle mathematics exams. This implies that in most mathematics lessons, students just adopt surface learning approaches that are not capable of imparting to them meaningful understanding of the concepts and that they

might fail due to a particular study habit. Their study suggests that both teachers and students should work together to design and develop the best study techniques that will enhance a deep understanding of mathematics lessons. Mathematics teachers must help their students gain a deep conceptual understanding. To confirm that students have truly mastered a concept, they should be able to show 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 help students develop the math skills that are necessary for progression and innovation in STEM-related fields.

A need to establish special interventions that reduce math anxiety and/or reduce the negative impact of math anxiety on achievement was also proposed by Ramirez, Shaw and Maloney (2018). These researchers presented a review of past studies that investigated the association between math anxiety and math achievement, factors that can cause math anxiety, characteristics of students that can increase their susceptibility to math anxiety, and efforts that educators can take to remedy math anxiety. Their study indicated that math anxiety can result from poor math skills, genetic predispositions or socio environmental factors such as negative math-related class experiences, home experiences around math and how they interpret their previous math experiences and outcomes of their efforts in solving math problems. The paper addresses several mechanisms that teachers may use to help students develop self-concepts and build a strong positive attitude toward the subject.

Moreover, studies show that teachers' attitudes and beliefs about mathematics, such as the usefulness of mathematics, the way mathematics should be taught and learned, the difficulty or ease of mathematics, and gender ability in mathematics achievement, affect their own attitude toward the subject, which in turn has a significant impact on student's performance. Generally, the literature has confirmed that student's and teacher's attitudes toward school and learning are important predictors of student's academic achievement (Alegre et al., 2020). A study pointed out that teacher's behaviours may increase the student's math anxiety if they put too much pressure on the student (Marpa, 2021). This kind of pressure seems to be the common challenge faced by the students in their daily learning process, and it originates from their teachers and family members who place very high expectations for students to excel in mathematics. Competitive pressure from peers and friends also tends to increase students' anxiety in learning mathematics.

While we all encourage students to work hard in their studies, the study found that too much emphasis on attaining excellent results in examination creates a potential worry, fear and anxiety that ends in emotional or psychological disorders. Their study calls for all parties to establish good mechanisms for controlling and minimizing the high-performance pressure. Unfortunately, some of the mathematics teachers relate with their students in a too strict manner, which results in a significant fear of asking for clarification when they do not understand or volunteer to answer a question. This results in total hatred of both the teacher and the subject. To avoid this problem, mathematics teachers are supposed to use a variety of techniques that will make their students feel at ease throughout the lesson.

Among such techniques are the use of interactive/student centered approaches of teaching, use of differentiated tasks, giving personalized constructive and timely feedback, motivating or awarding the high achievers and the most improved students, encouraging the low achievers as well as focusing more on students' ability to solve problems rather than getting good grades (Xia, 2020). In addition, mathematics teachers should plan their lessons in a way that will help students make connections between the concepts taught in class with real life application.

Another study conducted emphasized 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 (Spooner et al., 2019). These researchers pointed out those students need instructions that focus on foundational mathematics skills, such as number sense, while applying these skills to higher levels. The issue of imparting numeracy skills to children was also emphasized, who described numeracy as a critical awareness that builds bridges between mathematics and the real-world, with all its diversity (Tout, 2020). This researcher suggested that for students to gain numeracy skills, teachers should use a problem-solving, investigative, open-ended approach when teaching and use real texts and real situations to make connections between mathematics and the real world.

In addition, we found another strategy for teaching mathematics that insists on designing mathematics lessons in a way that will help students make connections between mathematics concepts covered in class with real life experiences. This recommendation was proposed, whose study found the level of mathematical connection ability of most students to be very low (Siregar et al., 2017). Their study therefore calls for mathematics

teachers to design and apply deeper teaching strategies that will enable students to establish a meaningful connection between classroom mathematics and life experiences. These scholars also recommended further research to examine what causes the lack of mathematical connection ability of junior high school students in Indonesia. This recommendation can also work in other countries, including Tanzania.

The use of technology in teaching and learning mathematics has been mentioned by several scholars as a possible means of improving students' achievements. Among such scholars, pointed out that curiosity and motivation can also be supported by the use of digital tools as instruments of action learning (Abramovich et al., 2019). Another study found that the use of the mobile application in teaching mathematics to Grade 8 students somehow helped to enhance students' achievement and learning (Etcuban et al., 2018). This study therefore recommended that the administrator enforce and include the use of the mobile application in carrying out learning to its maximum, and teachers should equip their learners with the latest technological skills so that they may compete globally. As explained, integration of ICT in mathematics is not merely using computers for typing and printing questions, searching and delivering lessons *via* PowerPoint but rather using ICT in teaching various topics in mathematics and encouraging students to use technology in mathematics learning (Marpa, 2021).

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 et al., 2020). Assessment in mathematics should focus more on authentic assessment rather than just 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.

METHODOLOGY

This study focused on three methodological approaches. The first was a scoping review of previously published studies that helped to identify the effective mathematics teaching and learning strategies used in a variety of classroom practices and in different settings and levels. Unlike systematic reviews and meta-analyses, the goal of scoping reviews is just to describe the literature and other sources of information while including findings from a

range of different study designs and method.

The results from a scoping review often focus on the range of content identified, and quantitative assessment is often limited to a tally of the number of sources reporting a particular issue or recommendation (Sucharew et al., 2019). The second methodological approach was a sample survey that enabled the researchers to inquire about the perceptions of teachers and students on the practicability of the reviewed strategies in Tanzanian classrooms or contexts. Both teachers' and students' responses are summarized in sections secondary school teachers' perceptions of effective strategies for teaching and learning mathematics and Secondary school students' feedback on effective strategies for teaching and learning mathematics.

The third approach was a case study, whereby three secondary schools were involved in a Mathematics Teaching Support Programme in which the proposed strategies were applied in classroom settings. The researchers recruited twelve (12) Mwenge Catholic university students who were pursuing degree programmes in mathematics, either from Bachelor of Science in Mathematics and Statistics or from Bachelor of Education (Science), and requested that they participate in the teaching support programme through a volunteering basis. Before sending them to the field, we trained them on how to use the proposed strategies in the classroom settings, and they attached them to Form one and form three students in the selected schools where they taught them for a period of two months. The selected schools had only one mathematics teacher who was servicing all students in the respective schools, from one to form four. The schools were also located in a neighborhood of Mwenge Catholic University, which enabled the volunteers to use just a small amount of transport cost to and from schools. Lessons learned from this programme are summarized in section evidence from maths teaching support programs.

Generally, this paper addresses three research questions:

1. What does the literature say about effective strategies for teaching and learning mathematics?
2. How do teachers' and students' perceptions match the documented/reviewed teaching and learning strategies, especially in the Tanzanian context?
3. What are the challenges associated with the implementation of the suggested strategies in teaching and learning mathematics?

4. What are the possible interventions for addressing the massive failure problem in mathematics subject? Analytically.

RESULTS AND DISCUSSION

Results from scoping review: Suggested strategies for teaching and learning mathematics

A total of 30 articles were reviewed to gather effective strategies for unlocking students' potentials in mathematics, as summarized in section challenges associated with the implementation of the suggested strategies in teaching and learning mathematics. These strategies included the use of games and visual aids and the use of technologies such as computers, problem-solving techniques and collaborative learning. Previous scholars have also insisted that teachers and guardians should avoid putting too much pressure on excellent performance because this pressure leads to anxiety and phobia, which also limits students' learning. Instead, teachers were advised to help their students acquire study skills and examination techniques that would enable them to gain a deep understanding of the concepts and be able to make connections between the concepts covered in class and real life experiences. Generally, these strategies can help teachers plan and present their lessons more effectively while helping their students build positive attitudes toward mathematics subjects.

Results from survey: Teachers' and students' feedback

Secondary school teachers' perceptions of effective strategies for teaching and learning mathematics: The reviewed strategies were shared with some secondary school mathematics teachers in Kilimanjaro to confirm their relevance and practicability in our Tanzanian classroom settings. A total of 18 mathematics teachers participated in the online survey, which gathered teachers' feedback. We found a weak correlation between teacher's perceptions of the applicability of some teaching strategies and what we found from the scoping review. While the literature associates student's poor performance with classroom practices that are often controlled or guided by teachers, the majority of teachers (12, 67%) believe that poor performance in mathematics is caused by student's negative attitudes toward the subject. Therefore, their major teacher's recommendation in addressing the issue of poor performance was to provide motivational speeches to students as much as possible, especially before the beginning of each mathematics lesson. The second recommendation from teachers was to train

both students and teachers about the role or application of mathematics in real-life situations so that they could value it more.

The teachers also call for students to be more committed in practising how to solve mathematics and to be more focused on studies. Finally, these teachers presented a concern of low teaching morale, which is caused by their large workloads and burnout that is not reflected in the students' performance. They requested that the government prepare and employ more mathematics teachers in schools so that they could help ease the current situation. These teachers also requested improved teaching and learning conditions, such as an increase in books, computers and projectors, which will make their lessons more learner centered.

Secondary school student's feedback on effective strategies for teaching and learning mathematics:

We visited six (6) secondary schools in the Kilimanjaro region to give them motivational talks on the relevance of mathematics in their real life 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 aimed at 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, the students' feedback shows that the majority 196 (79%) of students feel that the harsh treatment from their teachers is the major reason for such massive failure since it demoralizes many students and leads to hatred of not only the subject but also the teachers. This finding compares with what was presented, who found that some mathematics teachers become too grumpy and angry when students fail to work on a given question, and this teacher's anger creates more fear to students to ask for clarification or further interact with their teacher (Ayuwanti et al., 2021). This results in more failure in the consequent classroom tasks and exams.

Additionally, many students (182, 73%) raised a concern about the teaching methodologies that are used by mathematics teachers in class and admitted that many students they do not understand at all the concepts that are presented by their math teachers. We also noticed that many students (182, 73%) did not understand what they were taught in class. This lack of understanding of the concepts is also reflected in the item analysis reports, which are prepared by the National Examination Council (NECTA) after marking of national examinations. These reports show that most of

the students do not understand the questions that are asked, and as a result, they give responses that are quite different from the examiner expectations (NECTA, 2021).

The issue of focusing on students' conceptual understanding was also stressed, 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 (Amirullah et al., 2018). Other major concerns that were mentioned by students included the scarcity of mathematics teachers, lack of career guidance for students, inadequate language skills, especially in interpreting word problems in math, and a negative attitude toward the subject and math teachers. As reported, it is a school's obligation to see that their student's 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 (Furner, 2017).

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, the majority of students' responses show that the harsh treatment from their teachers is the major reason since it demoralizes many students and leads to hatred of not only the subject but also the teachers. This finding was obtained from a survey of 248 secondary school students in the Kilimanjaro region who were asked to give their honest opinions as to why many students failed mathematics. A summary of their responses is presented in Table 1.

As indicated in Table 1, 196 (79%) of the students 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 (182, 73%) confessed that they do not understand what they are taught in class. This lack of deep and meaningful understanding of the concepts covered in class is one of the reasons why students' memory retention is poor. We therefore recommend to the teachers to take into consideration all issues raised by students and design their lessons in a manner that students will be learning more meaningful rather than having just rote learning. Shallow understanding of the concepts is also reflected in the item analysis reports, which are prepared by the National Examination Council (NECTA) after marking of national examinations. These reports show that most of the students do not understand the questions that are asked, and as a result, they give responses that are quite different from the examiner's expectation NECTA, 2021.

Table 1. Massive failures in Mathematics.

Student's perceptions on causes of massive failure in Mathematics	Frequency (n=249)	Percentage (%)
Students have no life focus and career guidance	117	47
Student' s have negative attitude towards math	128	51.4
Mathematics teachers are too harsh to student's	196	78.7
Student's don't understand their maths teachers	182	73.1
Majority of Student's are not committed to studies	157	63.1
Inadequate number of maths teachers in schools	161	64.7
Language barrier-student's cannot translate the Math questions	114	45.8
Student's involvement in love affairs	126	50.6
Discouragement from teachers and peers	145	58.2
Mathematics concepts are too difficult for ss to grasp	154	61.8

Evidence from maths teaching support programs

In response to the existing gaps in mathematics teaching for schools around MWECAU, the department of Mathematics and Statistics decided to establish a Mathematics Club in which one of its activities is to offer teaching support in schools around the university on a volunteering basis. Approximately 40 students who are currently enrolled in mathematics-related programmes at MWECAU agreed to volunteer and were assigned schools to work on. We visited the schools to learn their specific needs and plan for activities that suit each school. However, the first visit to each school had a component of students' training on how to build positive attitudes toward maths and the application of mathematics in real-life situations. Since the selected schools also had a shortage of teachers, the volunteers were tasked with assisting the full-time teachers, especially in the form and form of three classes.

Together with the objective of assisting teaching in nearby schools, the Maths Teaching Support Programme gave us room to practice effective strategies that were gathered from scoping review exercises for the aim of assessing their relevance in Tanzanian school settings. These volunteers were trained on the proposed strategies and asked to apply them in their day-to-day teachings for a period of three months. Among other issues, these volunteers were instead 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

negative punishments to students who score low grades on tests or exams. In each school, the volunteers established mathematics where the students met and discussed several mathematics challenges and played mathematical 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 analysis of students' results before and after the programme showed a significant difference in their academic performance, as many students scored higher grades after the teaching support programme. In addition, statistical analysis of students' feedback on the teaching strategies that were used by volunteers, the students' performance before and after the MTSP programme and Mathematics teachers' feedback confirmed that students' achievement in Mathematics can be improved by helping students understand the value of Mathematics in their future careers, training students on how to build a positive attitude toward Math, building teachers' capacity in teaching Mathematics and improving the teaching and learning conditions at the school level (Buckley, 2013).

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

Through the survey, we were able to gather teachers' opinions on what they think might hinder them in using 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 a number of concerns that might limit them. Among their major concern were the large teaching workloads, which made them too busy to prepare interactive and engaging lessons. For example, two out the three 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 of the teacher said it hard for him to use videos or make demonstrations by using computers in a school where there is no even a single computer or a projector.

Teachers also raised a concern about the negative attitude of their students toward mathematics, which affects their readiness to learn. Close to this, teachers also mentioned a tendency of some students to select only a few subjects (mostly 2 to 4), which they can concentrate and attain the minimum qualification for the award of form four certificate. They also add that when this happens, the most likely subject to be dropped is mathematics since the majority of the students find it too difficult to them and they do not understand exactly why they should learn some of the mathematics concepts. Inadequate knowledge of both content and pedagogical skills to handle some of the mathematics topics was mentioned as one of the challenges for implementing the suggested strategies.

Teachers indicated some gaps in their understanding of some topics and added that if a teacher is not competent enough in a particular topic, it will also be hard for him/her to prepare a lesson that will help students gain a meaningful understanding of the concepts. They also said that when they were in teacher training colleges and universities, they did have an opportunity to go through all the topics that are in the current mathematics syllabus for secondary schools due to time shortages 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.

Generally, teachers' opinions show that the proposed strategies are very effective in unlocking students' potentials in mathematics, but there is a need to strengthen teachers' capacity to implement them. They also suggest that students should also be trained and helped to build positive attitudes toward the subject as well as guided on how they can use mathematics concepts and ideas in solving real-life problems.

Possible interventions for addressing the massive failure problem in mathematics subjects

From the study, we gathered the following ideas for effective interventions that can help to address the massive failure challenge in mathematics:

- To conduct school- and cluster-based training for mathematics teachers on both content and pedagogical skills.
- To conduct school- and cluster-based training for students on the real-life applications of mathematics concepts and possible career opportunities for mathematics majors.
- To employ an adequate number of mathematics teachers in all schools so that they may have manageable workloads and be able to prepare meaningful teaching and assessment activities
- To establish volunteering programmes in universities and colleges (i.e., Mathematics Teaching Support Programmes), mathematics teacher's trainees and other mathematics majors will be involved in supporting math teaching in schools where there are not enough full-time mathematics teachers.
- To ensure the availability of adequate teaching and learning resources in schools.

CONCLUSION

The central intent of this article was to provide insight into effective strategies for unlocking students' potentials in mathematics by drawing evidence from scoping review and from the actual math teaching support programme conducted in selected secondary schools in the Kilimanjaro region. Feedback from mathematics teachers who are currently working as full-time employees in secondary schools helped to assess the relevance of the proposed strategies. Generally, the majority of teachers agreed that these strategies are effective and, if well implemented, may help to improve students' performance. However, these teachers raised concerns about some implementation barriers, such as the availability of teaching and learning resources, especially when they want to integrate ICT into teaching mathematics. The large workload, inadequate content and pedagogical skills and poor student attitudes were other concerns from teachers who were 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. The study concluded by giving some suggestions for possible interventions that may help to improve the students' performance. Future work may involve an experimental study to test the

effectiveness of each proposed strategy in various classroom settings in Tanzania.

ETHICAL STATEMENT

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Conflict of interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

Informed consent

Informed consent was obtained from all participants involved in the study.

Ethical approval

Ethical approval was not required for the scoping review. However, all study participants consented voluntarily to participate in the study and were fully informed about the study goals.

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