Original Research Article

Effects of Participatory Teaching Methods on Students' Learning of Mathematics and Biology Subjects in Tanzania

Abstract:

This paper originates from a study on the effects of interactive teaching methods on students' learning of mathematics and biology at Tanzania's ordinary level secondary schools in Mwanza region. The qualitative technique was used in conjunction with the quantitative data. The 111 participants were chosen using simple random selection and selective sampling methods. In addition, the study collected data via surveys, interviews, focus groups, observations, and documentary reviews. In contrast to the content analysis that was performed on the qualitative data, the quantitative data were manually evaluated and shown as frequencies, percentages, and tables. The research revealed that students had a positive attitude toward participative teaching methods and a desire to learn. According to studies, students' comprehension of math and biology at a basic level can be improved by adopting participatory teaching methods supported by suitable T/L materials and qualified teachers.

Keywords: Participatory Teaching Methods, Students' Learning, Mathematics, Biology and Tanzania

1.0 Introduction

Planetary evolution and advancement are currently occurring quickly. The educational system of a country is fundamentally what determines its progress. People can develop new skills, information, and habits through education, enabling them to thrive in society. The main goal of biology and math instruction is to provide students with the knowledge, skills, and attitudes they need to be successful in the workplace. According to Yair (2000), education that is authentic, demands skills, and gives students autonomy that optimizes the learning experience for students. Similarly, Chung Ho (2007) advocated that education is one of the most direct methods to shape the political culture of a country insofar as it tries to mould students' familiarity and sympathy with it, as well as strengthening civil society based on mutual responsibility and civil self-respect. As a result, teachers are the most important factor in the learning process and possess unrivalled authority. At the end of the day, they must ensure meaningful learning in their capacity as facilitators, guides,

assistants, and directors of the learning process. Teachers have the authority to direct students during the learning process, which gives them the capacity to destroy, spoil, and/or make learning meaningful. Similar to this, LEECU (2021) asserts that "If teachers are effective, learners are stimulated and supported to actively participate in learning based on appropriate policy and curricula, school management supported by appropriate systems and effective supervision by Government; schools have appropriate and sufficient infrastructure; and communities are empowered and involved in to support, monitor, and contribute to identified needs of schools, then improvement in quality learner outcomes will be achieved." Nyerere (1967) made the following points to illustrate the influence of teachers in the learning process and in influencing individual and societal aspirations through the students they work with.

"Teachers can make or ruin our society. As a group they have a power which is second to none. It is not the power of man with a gun; it is not a power which can be seen by a fool. It is the teacher more than any other single group of people who determine attitude and shape ideas and aspirations of the nation through the learners they deal with".

The ability of teachers to effectively educate is crucial in understanding the significance of their role as learning facilitators. Teachers must employ interactive teaching and learning strategies, according to UNESCO (2015), that encourage students to take an active role in their learning and to work collaboratively as well as on their own initiative.

2.0 Importance of the Participatory Teaching Methods to Students' Learning

The most effective teaching techniques consider the learners' aptitudes, interests, ages, backgrounds, and experiences, including any special requirements. The process of selecting the subject matter and teaching techniques that will best accomplish those objectives is known as the teaching method. After putting the procedures into practice, evaluating the learning activities' success and keeping track of both the positive and negative outcomes is what makes up the teaching method. According to LEECU (2021), participatory methods are those that give students the chance to actively participate in their own learning. Pupils engage in a variety of activities such as exploration, interaction with the learning materials, sharing of ideas, group learning, investigation, decision-making, observation, and problem-solving.

Teachers should employ interactive teaching and learning strategies to help students learn more in the classroom and attain the desired learning outcomes. LEECU (2021) defines teaching as a process that facilitates and promotes learning through changes occurring to the learner in order for him or her to achieve desired outcomes demonstrated in terms of the cognitive, psychomotor, and affective domains, i.e. the ability to solve problems, communicate, organize, work cooperatively, and interpret situations/events. Similarly, Malawi Institute of Education (2004) emphasizes the following qualities of participatory teaching methods: Effective participatory teaching methods include student involvement and interaction, clearly stating learning objectives at the start of the lesson, using questions effectively, and using a variety of instructional techniques, thereby varying the routine. Independent reading combined with presentations and/or demonstrations.

(i) Since classes are collections of individuals, effective participatory methods accommodate the needs of a given group of students and adjust their instructional format if necessary. Formats that provide opportunities for interaction on three levels are the most effective, between the instructor and the class as a group, between the instructor and students as individuals, and among students.

(ii) Gives students the opportunity to think through issues and promotes respect for other students' ideas.

(iii) Encourages every pupil to express his/her views freely since the emphasis is on enquiry-type activities and;

(iv) The environment is democratic whereby the teacher facilitates a process of learning in which students are encouraged to be responsible and autonomous.

Considering this, educators should design an environment for active learning that fosters students' perceptions of competence and autonomy. This includes giving students options and chances for self-directed learning, as well as developing learning activities that may help students feel more in control of their learning. In fact, it has been demonstrated that intrinsic drive is a crucial aspect that might increase students' perceptions of their course's learning (Ferreira, Cardosob &Abrantesc, 2011).

With their diverse origins, interests, learning velocities, and learning styles which include auditory, visual, audio visual, and tactile; participatory teaching and learning methods promote interactive learning. The Chinese proverb "I hear, I forget, I see, I remember, I do, I comprehend" is in line with the use of various participatory teaching and learning techniques. According to Wolhuter (2014), one of education's objectives should be to encourage students to engage in active learning and develop into lifelong learners. Participatory teaching techniques promote communication between educators, learners, and the environment in which learning takes place. Generally, participatory teaching methods according to LEECU (2021) plays the following role in the teaching and learning:-

(i) Promotes learners' participation and engagement and so increases their interest and motivation to learn.

(ii) Involves students in learning-process activities rather than passive listening.

(iii) Provides more frequent and immediate feedback to students.

(iv) Promotes deeper learning and leads to development of higher order skills and competences such as critical thinking, problem solving, and communication.

(v) Learners master the concepts learnt and so can retain and apply what is learnt.

(vi) Learners can monitor their own learning and so take greater responsibility over it.

(vii) Improves interpersonal skills, such as team spirit, collaboration, collective responsibility.

(viii) Creates opportunities for differentiated instruction.

(ix) Promotes understanding: "I hear, and I forget. I see and I remember. I do and I understand."

3.0 Constructivist Theory of Learning

Vygotsky (1978) emphasizes that participatory learning is based on constructivism, a theory of learning that asserts that knowledge is actively created rather than transmitted to students. Similar to Tanner (2007), who argues that the central tenet of constructivism is that knowledge is created rather than discovered, constructivism has also led to the creation of teaching and learning environments that emphasize and encourage student participation in both the teaching and learning process. This indicates that the focus has changed from teaching to learning.

According to Mtavangu (2017), Tanzania, like other countries in sub-Saharan Africa, places a lot of attention on competence-based curricula since it considers them to be a good method for teaching that may help a country develop sustainably in all spheres of life. Through student practices, which put the students at the centre of the learning process, the classroom is made more engaging. The key to attaining meaning or understanding, according to constructivists, is integrating information, relating it to one's own past knowledge, and cognitively processing it. Additionally, they believe that social interaction and conversation are the best ways for kids to learn since they provide them the ability to contrast their own and other people's understandings (John, 2016).

4.0 Methodology

A study was conducted in 2011 in Mwanza region on the effects of participatory teaching methods on students' learning of mathematics and biology subjects at ordinary level secondary schools in Tanzania. Case study design was employed to give a thorough descriptive analysis of a single individual, group, or events. The study was carried out in three (3) secondary schools in Nyamagana district in Mwanza region, the second largest city in Tanzania involving 111 respondents (90 students, 12 subject teachers, 3 academic deans and 6 heads of departments). The qualitative method was used in conjunction with quantitative data. Simple random sampling and purposive sampling techniques were used to select 111 participants. Additionally, the study gathered information through questionnaires, interviews, focus group discussion, classroom observations and documentary reviews. Quantitative data were manually examined and presented as frequencies, percentages, and tables, while qualitative data were subjected to content analysis.

5.0 Findings and Discussion

5.1.1 Teachers' Use of Participatory Teaching and Learning Methods

The first objective of this study was to examine the teachers' use of the participatory teaching and learning methods. To achieve this objective, a total of 90 secondary school students were required to identify the teaching methods used by teachers in their schools in the process of teaching and learning. 57 (63.3%) of the students' responses indicated that teachers used the

lecture method and brainstorming respectively. 48 (53.3%) showed that teachers used Questions and Answers. 23 (25.5%) indicated that teachers used group discussion, while twenty-two (24.4%) revealed that teachers used jigsaw and 20 (22.2%) of the students' responses indicated that teachers were in favour of group work. When asked to mention the commonly used teaching methods by Biology and Mathematics teachers when teaching, students indicated the lecture method, questions and answers, brainstorming, group discussions, jigsaw and group work as the most common methods in the order of magnitude shown in figure 1.

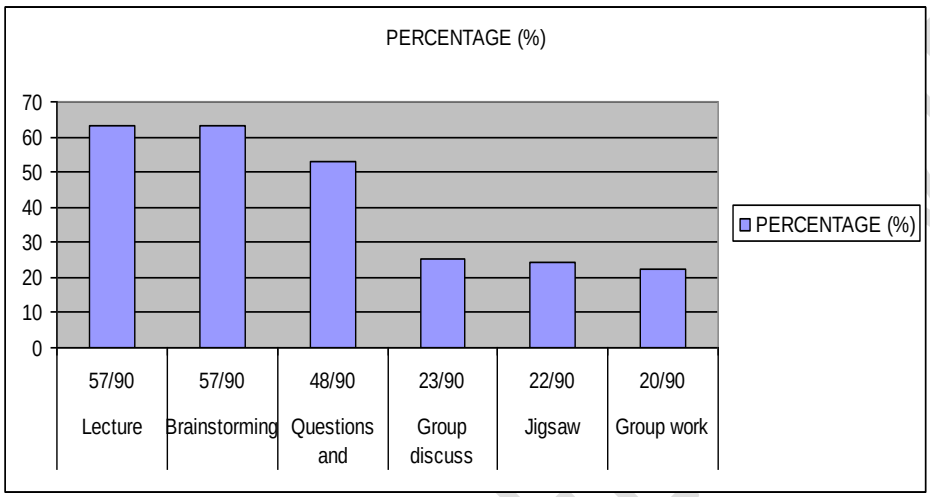

Figure 1: Students' Responses on the Commonly Used Teaching Methods

Source: Field data (2011)

Similarly, Mbalamula et al. (2017) found that college principals in the two teacher-colleges they studied strongly encouraged their instructors to use a variety of teaching and learning methods in their daily lessons. However, during classroom observations, the researcher found that instructors primarily used question-and-answer techniques and group discussion through discussion boards. The results show that, despite tutors' best efforts, the participative approach was not successful in the two teacher training colleges. In a similar vein, Otaala, et al. (2013) believe that many teachers have abandoned good teaching approaches in favour of "coaching" and drilling students to pass the national examinations.

5.1.2 Responses from Academic Deans

Three academic deans in total; one from each school were questioned about the methods that biology and math teachers used to instruct and learn their students. Three academic deans (100%) stated that there was little use of participatory teaching and learning techniques by biology and mathematics teachers, which is an undemocratic method of instruction. Most teachers prefer to employ traditional teaching and learning techniques over more contemporary ones that involve more students in the teaching and learning process.

5.1.3 Responses from Subject Teachers

Twelve subject instructors were interrogated to learn more about the usage of participatory teaching and learning strategies by teachers. Eight (66.6%) of the twelve subject teachers reported employing participatory teaching and learning techniques only sometimes or ineffectively, despite their relevance, due to a lack of resources, including libraries, laboratories, textbooks, reference books, and trustworthy infrastructure. One of the biology teachers made the following remarks to emphasize the significance: -

> *"If the teacher links the students' prior knowledge, ideas, and opinions, participatory teaching methods improve learners' achievement because they can develop the critical thinking skills and knowledge that the curriculum requires of them. Students differ in terms of attitudes, knowledge, and experiences. Using a variety of teaching and learning techniques, a teacher must inspire and maintain a student's interest. Due to inadequate teaching and learning resources and a lack of in-service workshops and trainings, teachers are having trouble implementing participatory teaching and learning techniques".*

The above quotation indicates that secondary school teachers were less in favour of participatory teaching and learning methods due to lack of teaching and learning materials, the nature of the curriculum and lack of in-service trainings and workshops. Interestingly, they knew that participatory teaching and learning method was effective but could not practice it.

5.1.4 Responses from Heads of Departments

Biology and mathematics teachers used participatory teaching and learning strategies only infrequently, according to six department heads who took part in the interview. When pressed for an explanation, they stated that the lack of suitable teaching and learning resources including textbooks, reference books, labs, libraries, infrastructure, teachers' manuals, and overstuffed curricula was impeding their use of participatory teaching and learning techniques.

Through observation, little evidence of the use of participatory teaching and learning methods was observed such as splitting the class into smaller groups, allowing learners to interact with one another. The major factors for application of the lecture method were acute shortage of teaching and learning materials, overcrowded classrooms, prescriptive curriculum and teachers' incompetence.

5. 2 Participatory Teaching and Learning Methods and Classroom Interactions

The second objective of this study sought to examine the impact of Participatory Teaching and Learning Methods in bringing about Classroom Interactions. To achieve this objective, Varieties of instruments were used in gathering information on the research task. The used Instruments included questionnaire which were administered to academic deans, subject teachers and students; interview which were administered to Biology and Mathematics heads of the department and observations which were used to study the classroom situation.

Through questionnaires, 105 respondents were asked to tick on the teaching and learning methods which brought about more classroom interactions during the teaching and learning process. Their responses are summarised in the table below:

Table 1: Respondents' Views on the Participatory Teaching Methods T/ L Method

T/L Technique	S N=90	AD N=3	ST N=12	TOTAL N=105	%
Think, Pair, Share	64	2	10	76	68.4
Gallery Walk	58	3	5	66	59.4
Jigsaw	50	2	5	57	51.3
Group Discussion	80	3	11	94	84.6
Plays and Games	66	2	8	76	68.4
Dramatization	72	3	7	82	73.8
Questions& Answers	68	2	11	81	72.9
Project	75	3	12	90	81.0
Story telling	57	1	6	64	57.6
Concept map	63	2	9	74	66.6
Concept cartoon	55	2	7	64	57.6
Group work	75	3	8	86	77.4

Brain storming	70	2	10	82	73.8
Study tour	78	3	11	92	82.8
Demonstration	86	3	10	102	91.8
Role play	69	2	7	78	70.2

Key: S =Students, AD =Academic Deans, ST =Subject Teachers,
Source: Field data (2011)

Analysis in the table above indicated that 102 (91.8%) mentioned demonstration, 94 (84.6%) group discussions, 92 (82.8%) study tour, 90 (81%) project, 86 (77.4%) 64 group work, 82 (73.8%) brainstorming and dramatization, 81 (72.9%) questions and answers, 78 (70.2%) role play, 76 (68.4%) plays and games and think, pair and share, 74 (66.6%) concept map, 66 (59.4) gallery walk, 64 (57.6%) concept cartoon, 64 (57%) storytelling, and 57 (51.3%) jigsaw.

When asked why the approaches stated led to class interactions, they responded that they gave each student in the class a chance to engage in learning, interact, and develop confidence. The results demonstrated that students, academic deans, and subject teachers chose demonstration, group discussion, study tours, projects, and group work as the most effective teaching strategies. According to observation, learner-centred and teacher-centred approaches of teaching and learning are most frequently used.

5.2.1 Responses from Heads of Departments

During the interview, six (6) heads of the biology and math departments were questioned about the connection between classroom engagement and instructors' usage of participatory teaching and learning approaches. Four (66.6%) of the six department heads who were interviewed noted that classroom interaction increased as instructors used more participatory teaching and learning techniques and decreased as teachers used more traditional teaching and learning techniques.

When asked why most teachers didn't use participatory teaching and learning techniques, it was stated that a lack of and/or a scarcity of teaching and learning resources for conducting experiments, projects, and demonstrations led to ineffective teaching and learning and prevented teachers from using participatory teaching techniques. Due to the students' dependence on what the teachers were teaching, this resulted in few or no classroom interactions. One head of Mathematics department said:

> *"To facilitate effective student engagement and interaction in the session, teachers must have access to adequate teaching and learning materials. Without sufficient supporting*

materials that enable interaction between a teacher and students, or between students themselves, how can teachers use participatory teaching methods?"

According to the phrase above, instructional resources are crucial for fostering classroom relationships through participatory learning. The remaining 2 (33.3%) people commented that there was no connection between classroom interactions and participatory teaching and learning approaches. When asked what encouraged classroom interactions, they said that the general learning environment, the ability of specific teachers, and the attitude of the teachers and students all played a role. Similar to this, Kavindi (2014) discovered in his research at a teachers' college that inadequate infrastructure and a shortage of tutors are some of the obstacles to implementing a competence-based curriculum.

5.3 Reasons for Poor Learning Outcomes in Mathematics and Biology despite the Advocacy of Learner Centred Approach

The third research objective looked at the factors that led to poor student learning results in mathematics and biology respectively, despite the advocacy of the learner-centred approach and the paradigm change from conventional to modern teaching. Ninety (90) students, twelve (12) subject teachers, six (6) department heads, and three (3) academic deans participated in the survey. Through interviews, documentary consulting and focus groups, data for this study were acquired. Academic deans, teachers and students were given questionnaires, and department heads for biology and mathematics were given interviews. The learners were involved in the focus group discussion.

5.3.1 Students' Views

The data acquired from 90 pupils (100%) revealed that there was a severe lack of teaching and learning resources such textbooks, supplemental books, science equipment, teachers' guides, laboratories, infrastructure, and libraries. The learning outcomes of the kids were negatively impacted by them. Through surveys, 12 subject teachers (100%) stated that it was challenging for them to use participatory teaching and learning techniques, which made it challenging for students to meet the intended goals. Effective parent-school collaboration has been demonstrated to be a valuable strategy for assisting the school in carrying out the curriculum. These results are consistent with those of Johnson (2015) and Juvenile (2017), who showed that schools that

regularly work with parents to design and implement a variety of initiatives aimed at ensuring that children learn both at school and at home are very successful in delivering competency-based curricula. Sheldon (2009), on the other hand, said that competence-based curricula necessitate a lot of decision-making, largely from parents and instructors, to ensure that a student is watched over both at school and at home, which results in effective teaching and learning. Similarly, Mosses and Wamalwa (2019) have pointed out that improving school infrastructure is a crucial step in guaranteeing that the so-called competence-curriculum is successfully implemented in schools.

The students' concerns about the inadequacy of the learning resources are supported by ELECU (2021), which, through the diagram provided, reflects the interactions between the teachers, adequate infrastructure, community support, appropriate policies and curricula, and effective government supervision in fostering a quality education that ensures the production of a competent graduate with the necessary knowledge, skills, and attitude that fits him/her in the workplace.

> According to ELECU (2021), "If teachers are effective, learners are stimulated and supported to actively participate in learning based on appropriate policy and curricula, school management supported by appropriate systems and effective supervision by Government; schools have appropriate and sufficient infrastructure; and communities are empowered and involved in to support, monitor, and contribute to identified needs of schools, improvement in quality basic education with high completion rates and quality learner outcomes will be achieved."

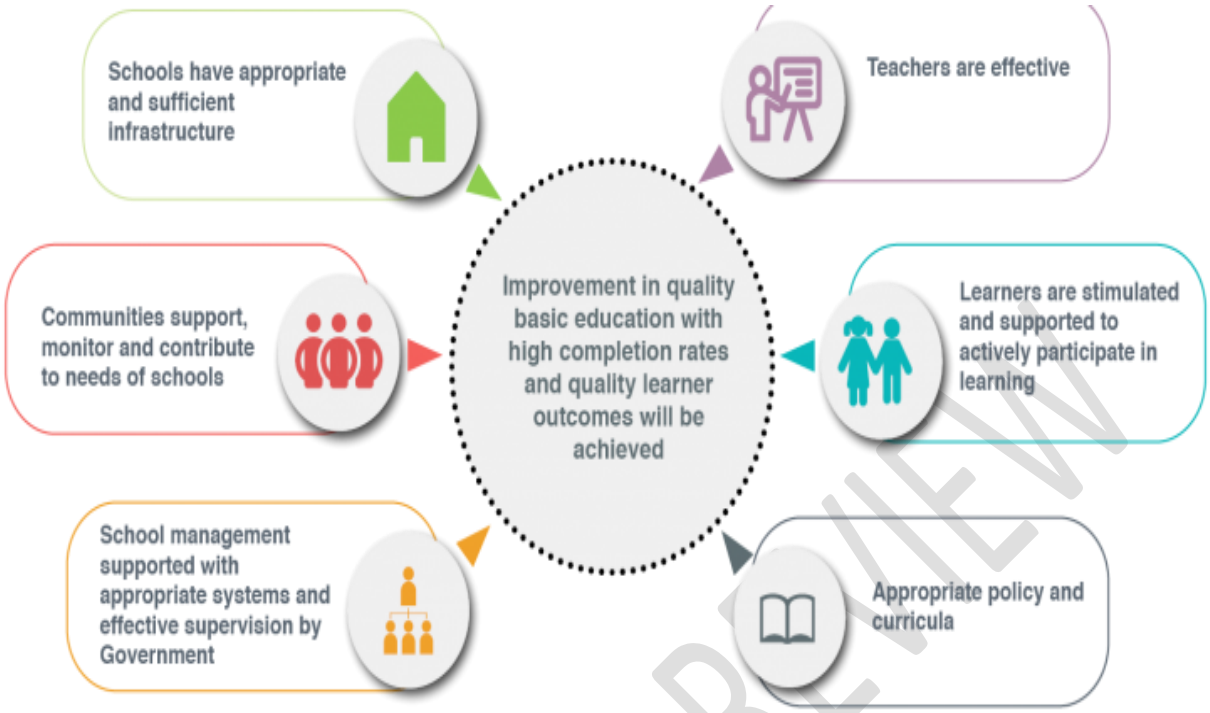

Figure 2: Factors that can lead to quality learner

Source: ELECU (2021)

5.3.2 Use of English Language

Findings from observation suggested that both students and teachers lacked the English language proficiency in teaching and learning, which limited teachers' ability to initiate classroom interaction through participatory teaching approaches. Code switching was observed being strategically used by 4 subject teachers (66.6%) to improve interaction in their classes, encourage pupils, and meaningfully negotiate instructional information.

5.3.3 Lack of Students' Seriousness and Negligence

When teachers tried to use even the most basic kind of participatory teaching and learning, some of the pupils could be seen to be bored. Additionally, it was shown that students' lack of sincerity and neglect in engaging in active learning processes led to subpar learning outcomes. Students lacked discipline, commitment, and confidence when studying biology and mathematics. Interestingly, according to Tilya and Mafumiko (2010), some students and instructors have opposed the transition in other places (to mean the paradigm shift from teacher-centred to

student-centred). Some students flourish while learning from a teacher, and many of them say they prefer it. According to Weimer (2002), this occurs because student-pedagogy places less demand on them up until the night before an exam, whereas the former necessitates taking an active part in class and completing assigned readings.

5.3.4 Negative Attitude towards Mathematics and Biology Subjects

According to two academic deans (66.6%), students' attitudes toward mathematics and other science courses including biology, physics, and chemistry were negative, which led to subpar learning outcomes. They further stated that many kids lacked self-assurance, obedience, and dedication when learning biology and mathematics. The focus group discussion revealed that students felt their math and biology teachers were insufficiently qualified. It was noted that just 2 (33.3%) of the 6 Biology and Mathematics teachers at the studied schools had degrees; the other 4 had diplomas.

6.0 Conclusion

The results show that integrating interactive and student-centered approaches into the classroom fosters a more conducive learning environment. Students show increased interest and enthusiasm for subjects, but they also understand more complex concepts. The participatory methods used, such as group discussions, practical exercises and interactive technology integration, have proven to be effective tools to enhance learning. Additionally, research shows that the benefits of inclusive teaching methods go beyond immediate academic benefits. Students ‘critical thinking, problem solving and cooperative teamwork showed significant improvement. This holistic approach to education fits well with the changing needs of the Tanzanian education system, emphasizing not only mastery of content but also the development of essential skills.

Although the positive results are encouraging, it is important to recognize the need for continued research and evaluation to refine and adapt these teaching methods to the specific environment of Tanzanian classrooms. Collaboration between educators, policy makers and stakeholders is crucial for the sustainable integration of inclusive teaching strategies in the education system. Taken together, the results of this study show that inclusive teaching methods can positively transform the learning of Tanzanian students, especially in the subjects of mathematics and biology. In our pursuit of educational excellence, adopting innovative and student-centered pedagogies is a promising way to advance education in the Tanzanian context.

7.0 Recommendation

The progress of a country benefits greatly from education. Given the findings of this study, it is recommended that the government, through the Ministry of Education Science and Technology, collaborate with other educational stakeholders to provide schools with more funding to foster an environment that is favourable to effective teaching and learning. Planned in-service training programs and seminars ought to be started and maintained at the school level to enhance teachers' subject-matter expertise and pedagogical abilities. Heads of schools should be made aware of teaching methods through short courses and seminars, which are government-initiated processes that make sure they provide suitable incentives and rewards. This will help them feel more confident.

The study also suggests that participatory teaching strategies be used consistently in secondary schools since they foster critical thinking and active learning, which are crucial for education at this level, which is heavily reliant on student achievement. Interactive teaching methods enhance students' retention of learned content, remembering of information, comprehension of learning materials, and capacity to apply knowledge to novel circumstances or problems. The effectiveness of incorporating participatory approaches in teaching and learning remains crucial for maximizing effective learning on the part of students, but in practice application of the approaches is subject to contextual factors that present challenges for teachers while engaging students in the learning process.

Due to these issues, teachers frequently discover that they are only able to use a questions-and-answers method in this situation. The problems stem from the size of the classrooms, the instructors' workloads, and the pressure of the tests. Both privately owned and publicly supported secondary schools in Tanzania ought to employ an adequate number of instructors and provide ongoing pedagogical leadership training for them. The installation of ICT (Information and Communication Technology) equipment, the acquisition of adequate textbooks, the construction of enough labs, the improvement of indoor training at the school level, and the strengthening of parent-school ties are further recommendations. Secondary school graduates need to be equipped with the five crucial 21st-century skills of critical thinking, creativity, communication, teamwork, and character, enabling them to advance the country toward industrialization. This can be accomplished by effectively implementing participatory teaching and learning methods.

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