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Promoting girls' participation in science education: a Tanzanian secondary schools' perspective

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Abstract. This qualitative study explored teachers' roles in promoting girls' participation in science education in Tanzanian secondary schools. A phenomenography research design was adopted to capture the experiences of 40 participants involved in the teaching and learning processes. Data analysis followed Braun and Clarke's six stages of thematic analysis. Findings from observations, interviews, focus group discussions and documentary review indicated that teachers' roles for promoting girls' motivation to learn include: providing girls opportunities to learn, commitment in teaching, providing career advice, preparing well before teaching, evaluating learning and providing feedback, promoting girls' self-efficacy and upgrading knowledge. However, teachers faced challenges as they played their roles in making girls learn. The study recommends that the teaching and learning environment be improved. Adequate teaching facilities should be provided to teachers to ease their efforts in making girls learn Science. Studies with larger samples must be conducted across different educational levels in the country.

Keywords: science, girls, education

1. Introduction

Girls' participation in Science, Technology, Engineering, and Mathematics (STEM) education holds profound significance in today's interconnected world [43]. STEM knowledge is critical for developing innovators, problem solvers, and critical thinkers who can address global challenges and promote sustainable development [24, 77]. Therefore, a scientifically literate population is essential for socio-economic progress, making STEM education a key priority [64]. However, many studies reveal a troubling decline in students' attitudes, interests, and motivation toward science learning, particularly among girls in secondary schools [26, 66].

The underrepresentation of girls in STEM carries significant implications, especially considering that women constitute half of the global population [66]. This disparity early in education directly impacts women's participation and opportunities in STEM careers, limiting their potential contributions to these vital fields [61, 66]. Engaging girls in STEM not only addresses the persistent gender gap but also enhances economic opportunities for women, as STEM careers typically offer higher salaries and job security compared to non-STEM professions [24, 77]. STEM-related careers are also critically important for fostering a more academic and intellectually driven community [29]. Recognising the importance of scientific knowledge for socio-economic development and human survival, addressing the persistent global challenge of motivating girls to participate in learning science subjects remains crucial [66, 72].

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2. Literature review

2.1. Global patterns and regional variations in the underrepresentation of women in STEM fields

In 2021, women accounted for approximately 32.8% of tertiary education graduates in STEM across the European Union, a slight increase of 0.3 percentage points from 32.5% in 2020. This proportion aligns with similar trends observed in the USA and Japan, where women make up roughly 35% of STEM graduates [67]. Recent data show that female representation among STEM graduates in Europe varies significantly by country, with Romania and Poland leading at 42.5% and 41.5%, respectively, in 2021 [67]. This proportion reflects the ongoing underrepresentation of girls and women in STEM disciplines such as natural sciences, mathematics, information and communication technologies, engineering, manufacturing, and construction.

In Africa, Mutsvangwa and Zezekwa [51] emphasises the transformative potential of STEM education in achieving sustainable livelihoods and driving socio-economic progress in the region. This underscores the importance of expanding STEM opportunities for women on the continent to promote inclusive growth and innovation. However, less than 25% of African students in higher education pursue STEM qualifications, and among these, only about 30% are women, underscoring significant gender disparities [8]. This gap is especially pronounced in Tanzania, where, according to a UNESCO report, just 4.4% of female students at the tertiary level were enrolled in STEM-related programs in 2019, compared to 21.6% of their male counterparts [76].

2.2. Factors contributing to girls' underrepresentation in STEM

The underrepresentation of girls in STEM fields stems from various interconnected factors, including societal stereotypes, gender biases, and educational environments [62, 66, 72]. STEM fields are often viewed as masculine, leading teachers and parents to underestimate girls' abilities in science subjects from a young age [50]. Furthermore, socio-cultural norms and gendered expectations exclude girls from pursuing science subjects, affecting their educational opportunities and decisions about study and work [22]. Negative attitudes toward STEM, coupled with girls' low self-assessment and confidence in their abilities, also contribute to the problem [10, 19]. This lack of confidence often emerges early, with research indicating a steady decline in girls' belief in their math and science skills from elementary through high school, a trend that is further intensified by societal pressures and stereotypes discouraging them from pursuing STEM careers [19]. Environmental factors within schools also play a pivotal role; inadequate teaching and learning infrastructure and a shortage of science materials and equipment hinder effective science education [15, 35]. Additionally, the use of inappropriate teaching strategies by educators has been identified as a significant factor that diminishes girls' motivation to engage with science subjects [19, 73].

2.3. Initiatives to improve the situation of girls in STEM worldwide

Globally, many initiatives have been launched to boost girls' participation in STEM fields, underscoring the recognition that STEM education is crucial for economic growth, innovation, and societal advancement [65]. In the United States, the government emphasises that its economic strength, military capabilities, and intellectual leadership rely on robust STEM knowledge and skills [7, 65]. Thus, STEM education for everyone is emphasised through policies and practices designed to address the underrepresentation of girls, ensuring they have equal opportunities for future careers in these fields [40]. To this end, federal efforts are coordinated through strategic plans and initiatives to expand equitable, high-quality STEM education from early childhood through higher education, ensuring all students, including girls, have access

to rigorous and relevant STEM learning opportunities [66]. These efforts also include removing barriers to participation and retention in STEM, supporting educators, and fostering inclusive environments that promote belonging and engagement in STEM disciplines.

The U.S. government also collaborates with private sector partners and international programs to support girls' STEM education domestically and globally, recognising that empowering women in STEM addresses workforce shortages and drives economic development and gender equality worldwide [7]. During the Obama administration, a key strategy to address the growing demand for STEM professionals involved recruiting and training highly qualified individuals, specifically engaging underrepresented groups [7]. This approach recognised that segments of the population, such as girls and women, were not proportionally represented in STEM fields, and specific initiatives were launched to broaden their participation [80]. However, a critical shortfall in science and technology expertise among current and future workers threatens the nation's global sovereignty. Since women already "made up 46% of the total current workforce, but only held 24% of jobs in technical or STEM fields", they were considered a particularly good investment [80]. This recognition has led to increased efforts to promote STEM education, particularly for girls and underrepresented groups, to address the gender gap and ensure a diverse, skilled workforce for the future [48, 79].

In Australia, different policies have been made to improve the situation of girls' underrepresentation in science, with the government establishing several organisations and programmes in the country that raise the profile of science among girls [6]. Thus, attention was placed on teacher quality, including the quality of teaching science and mathematics using innovative inquiry-based approaches [75].

Similarly, in Africa, even though science education for girls has always been assigned high priority, studies have revealed that participation of girls in learning natural science subjects in secondary schools continues to be lower in number as compared to boys [25, 37]. This was fuelled by the inherent nature of education provision from colonial masters, which discriminated against girls and women from accessing education [49]. Moreover, it has been caused by different stereotype beliefs whereby STEM-related subjects like Physics, Chemistry and Mathematics are wrongly perceived as hard and more related to masculinity, while arts subjects are related to the feminine gender [37]. Additionally, the issue of men's dominance in society was explained as one of the major causes of poor engagement of students in education, as well as STEM [8, 30]. The society has a negative attitude towards girls' education and links them with caretakers of affairs related to home and parenting, like getting married, giving birth and taking care of the family [8, 49]. The discriminatory beliefs have led to a lack of sufficient support for girls in pursuing those subjects, leading to poor motivation and participation of girls in those fields, resulting in fewer women in careers related to STEM.

In South Africa, the under-representation of girls and women in STEM fields is a multifaceted issue further complicated by the country's history of racial inequality [49]. STEM fields have been historically dominated by men, particularly white men, influenced by Western patriarchal ideologies that deemed women intellectually inferior and unsuitable for such disciplines [49]. Consequently, the beliefs significantly influence girls' educational advancement, particularly in STEM fields where African women are notably underrepresented [18]. Recognising this disparity, some universities are actively implementing targeted policies to attract and support African students, specifically focusing on increasing African women's participation in STEM disciplines. However, while intended to promote inclusivity, the policies encountered resistance from dominant white groups within these fields. Despite ongoing efforts to increase the participation of girls and women, they remain significantly underrepresented.

Similarly, the Tanzanian government realises the importance of science education to the development of the nation and that of the world at large in this era of globalisation, hence underscoring the value of the participation of both girls and boys in building the nation [28, 34]. As a result, in order to ensure that education and training meet recognised regional and international quality standards and meet the needs of national development, it is stated in the educational policy that, "education in science and technology is essential in enabling citizens to understand their environment and contribute to national development" [78]. Additionally, among the objectives of science education is "to have a sufficient number of citizens educated in science and technology to meet the needs of national development" as highlighted in the country's education and training policy [78]. In that regard, primary school pupils begin to be taught science subjects in Standard III. In secondary education, from Form I to Form IV, all students study science subjects, including Physics, Chemistry, Biology and Mathematics until Form II. Additionally, all students continue to study Biology and Mathematics until Form IV as compulsory subjects, while Physics and Chemistry become optional subjects from Form III and IV, where students may choose to continue with these subjects [78]. On the contrary, even though science education is valued in Tanzania, the underrepresentation of girls and women in STEM persists regardless of the efforts [36]. Statistics show that only about 30 to 35 per cent of students study science subjects in Form III and IV, among them, girls are underrepresented [4, 78].

Professional development of secondary school teachers in Tanzania starts from teacher colleges or universities where trainees receive their training at certificate, diploma or degree levels [38]. Thus, while diploma holders qualify to teach form one and two, degree holders teach form three and four [31]. As a result, the varied professional training of teachers leads to a corresponding variation of their levels of professionalism and their perceptions of girls' motivation to pursue STEM. However, during their teacher education, teachers receive training for subject matter knowledge, professional study, as well as teaching practice [44]. Therefore, they are expected to possess the professional knowledge, abilities and competence necessary to employ a variety of motivational instructional techniques, recognise and meet the needs of their students [70]. However, the policy, curriculum, and subject syllabi for science subjects do not explain teachers' roles in making girls learn science subjects.

2.4. Gender disparities in science subjects in Tanzanian secondary schools

The gender gap in science subjects is vivid in Tanzania, where the number of girls enrolled on science subjects is lower than that of boys. In addition to the low number of girls, it is interesting to know that girls perform poorly compared to boys in science subjects in secondary schools. Gender disparity in science subjects in the Certificate of Secondary Education Examinations (CSEE) is illustrated in table 1.

Table 1 indicates a greater number of girls enrolled than boys in both years, as demonstrated by the figures for students who took mandatory subjects like Biology and Mathematics. However, there was still a disproportionately lower participation and performance among girls in all subjects, particularly Physics and Chemistry. These findings imply that girls are less motivated in science, reflected in their involvement and performance [66]. The persistent underrepresentation of girls in STEM fields is an increasing concern, particularly given the growing female population [65]. This disparity directly impacts women's representation in STEM workplaces, highlighting the need to address and rectify the factors contributing to this imbalance [66].

While previous studies, such as those by Itika et al. [27], Matete [47], and Kinyota [36], have explored girls' education in science within Tanzania, the specific role of teachers in motivating girls to participate in STEM fields in community secondary schools remains underexplored. This gap in research has prompted the need for a

Table 1
Number of students in science subjects in O-Level between 2018 and 2022 [53–57].

Subject	Year	Candidate sat			Candidate passed					
		Boys	Girls	Total	Boys	%	Girls	%	Total	% of total
Biology	2018	176922	182380	359302	116624	65.9	100907	55.3	217531	60.5
	2019	201510	220052	421562	125808	62.4	107152	48.7	232960	55.3
	2020	208792	226628	435420	128421	61.5	111864	49.4	240285	55.2
	2021	231142	256304	487446	199439	73.8	156217	61.3	325656	67.2
	2022	241815	280148	521963	177181	73.5	175885	63.0	353046	67.8
Basic Mathematics	2018	177414	181811	360225	42791	24.1	28912	15.8	71703	19.9
	2019	201859	220473	422332	49864	24.7	34710	15.7	84578	20.0
	2020	208732	226613	435345	50897	24.4	36685	16.2	87582	20.1
	2021	231044	256321	487365	56438	24.6	38239	15.0	94677	19.5
	2022	241762	280124	521886	60637	25.2	43815	15.7	104452	20.0
Physics	2018	72735	60881	133616	39343	54.1	21111	34.7	60454	45.2
	2019	69877	58567	128444	39746	56.9	22396	38.2	62141	48.4
	2020	66365	53977	120342	37759	56.9	21049	39.06	58808	48.9
	2021	65162	51448	116610	44096	63.5	23000	45.0	64096	55.3
	2022	63044	51428	114472	47062	74.8	30947	60.4	78009	68.3
Chemistry	2018	87973	77803	165776	60178	68.4	42286	54.4	102464	61.8
	2019	86116	76661	162777	70168	81.5	54784	71.5	124952	76.8
	2020	82626	71517	154143	74290	83.9	59989	83.91	134249	87.1
	2021	82228	69877	152105	77108	94.3	61946	89.3	139054	92.0
	2022	82445	72992	155437	78315	95.2	66900	91.9	145215	93.7

focused study on how teachers can enhance girls' participation in STEM. Teachers play a pivotal role in shaping students' attitudes and interests, yet their potential to inspire and support girls in overcoming socio-cultural and psychological barriers to STEM engagement has been relegated. Addressing this issue is crucial for fostering gender equity in STEM education and ensuring that girls are empowered to pursue future science-related careers, which are vital for innovation and sustainable development.

The failure to address the challenges faced by girls in science subjects significantly restricts their access to STEM education and career opportunities, perpetuating gender inequality and marginalisation [1]. This exclusion contradicts human rights principles and global efforts to promote equality. Recognising this, the United Nations adopted the Sustainable Development Goals (SDGs) in 2015, with Goal 5 emphasising gender equality and the empowerment of all women and girls without discrimination [77]. Increasing girls' participation in STEM subjects is a critical strategy for achieving this goal.

This study was, therefore, necessary to be carried out because its findings are expected to add to the existing body of knowledge, improve teaching and learning practices and inform different key educational stakeholders on issues related to effective teachers' roles for motivating girls to learn science subjects in community secondary schools [11]. The curriculum development institution and policy makers might also draw experiences from the study's findings and devise syllabi that are inclined to foster means through which science teachers are motivated to teach and encourage girls' education. Furthermore, the study is expected to improve teachers' teaching practice as they understand the factors contributing to the under-representation of girls in STEM. Two objectives, therefore, guided the study:

1. To explore the roles of teachers in making girls participate in learning science subjects.
2. To investigate the challenges teachers face in teaching girls to learn the science subject.

3. Theoretical framework

The study was guided by the Expectancy Value Theory of motivation and achievement proposed by Eccles et al. [17] [1]. The theory explains how students' expectations for completing a task or reaching a goal relate to the importance of doing so. It is one of the theoretical constructs of motivation that describes the nature of achievement [14]. The theory posits that learners' motivation and performance are influenced by their expectations of success and the value they assign to tasks. The Expectancy Value Theory was adopted in this study because it contains components necessary in motivating learners, especially girls, in their choices, persistence, and performance in learning. It helps teachers effectively play their role to motivate girls to learn science and mathematics.

4. Research methodology

4.1. Research approach and design

This study employed a qualitative approach because it allowed the researchers to obtain crucial information to address research questions [23]. The study employed a phenomenography research design founded by Marton [46]. It focuses on determining how groups of people experience, conceptualise, realise and understand various phenomena in the world around them [11, 81]. This design was helpful for the study as it enabled a deeper exploration of teachers' and students' lived experiences regarding teachers' roles in motivating girls and their impact on girls' learning of science subjects. In this way, the study provided rich insights into the practices and challenges of girls' engagement in science subjects within secondary schools.

4.2. Sampling procedures

According to the Mbeya Educational Officer, in 2023, the Mbeya Region had 203 government secondary schools. The region had 145,876 students, of whom 68,681 were boys and 77,195 were girls. The number of teachers in those schools was 4,907, and 1,494 were science teachers. A purposive sampling procedure was employed to select research participants, ensuring that individuals with relevant insights were included in the study [81]. Thus, four community secondary schools in the Mbeya Region were purposefully selected for this study, with two exhibiting strong academic performance and the other two demonstrating weaker results in the 2022 Certificate of Secondary Education Examinations (CSEE). This selection aimed to provide contrasting perspectives on the factors influencing girls' performance in science subjects within community secondary schools. The emphasis on academic performance is critical, as it is a key indicator of student motivation throughout the learning [65].

4.3. Sample size

The study involved 40 carefully selected participants, and a sample size was determined to be sufficient as data saturation was achieved. This means that no new themes or insights emerged during the qualitative data collection process, indicating that the information gathered was comprehensive and adequately captured the range of perspectives relevant to the research topic [81]. The study participants, therefore, comprise 16 science teachers and 24 Form III students specialising in science subjects. Among the teachers were seven females and nine males, all teaching Form III classes. The student group included six girls from each of four schools, aged between 15 and

17 years, predominantly from low-income families. In Tanzania, Form III is a pivotal stage where students decide their academic streams: science, art, or business. This decision significantly shapes their future academic and career paths, as noted by Ndalichako and Komba [58]. This critical juncture underscores the importance of targeted interventions to support informed choices during this phase.

4.4. Location of the study

This study was carried out in the Mbeya Region. The region was chosen due to high secondary school enrolment rates, with notable gender disparities in science performance [33]. The researchers were interested in community secondary schools because these schools were specifically introduced to achieve the goal of Education for All [74]. Education for All was a resolution under the auspices of the Dakar Framework for Action, adopted by the World Education Forum as a collective commitment of nation-states to reaffirm the vision of the World Declaration on Education for All that was adopted in 1990 [60]. Moreover, the enrolment in these schools was higher than in other public secondary schools, which enrol students with the highest performance [3].

4.5. Methods of data collection

The study employed different data collection methods, including the classroom observation method, the most reliable tool for gathering firsthand field information as the participants engage in actions and experiences in their natural settings [20]. Four observations were possible for each school, meaning that each form of three science teachers was observed. This method was also helpful in collecting information that could not be obtained through other tools. Therefore, non-participatory observation allowed the researchers to observe teachers' practices without direct involvement.

This study used semi-structured interviews and focus group discussions (FGDs) as the primary data collection methods. The researchers prepared interview guides that comprised open-ended questions (appendix A). According to Cohen, Manion and Morrison [9], open-ended questions allow researchers to probe more into the answers to collect detailed information. Kivunja and Kuyini [39] point out that, unlike other data collection tools, interviews enabled researchers to collect in-depth data from respondents. In addition, Patton [63] observes that interviews help generate rich qualitative data due to their flexibility, focus and time effectiveness. Researchers organised interviews in natural settings in schools without disrupting school timetables and ongoing classes. Gunawan [21] points out that interviews should not take long to avoid boredom. Thus, all interview sessions in this study lasted 45 minutes and one hour.

FGDs were conducted for students (appendix B). During FGDs, participants had time to share experiences, ideas and expressions of beliefs, meanings and values to arrive at a collective understanding of their perspectives on standard teaching methods that teachers used to motivate girls to learn science and mathematics. The details from interview responses and FGDs were noted and organised before a thorough analysis was done. Creswell and Creswell [12] note that field data should be subjected to a comprehensive, in-depth examination to remove all nuances that might destabilise the findings. Additionally, researchers conducted a comprehensive documentary review of educational materials, encompassing policies, basic and teacher education curricula, science syllabi, teachers' schemes of work, and lesson plans. The primary objective of this analysis was to evaluate how these documents highlighted the role of teachers in motivating girls to pursue science subjects. By examining these materials, the researchers sought to understand how educational policies and practices support teachers in fostering an inclusive and encouraging environment that

promotes girls' interest and participation in science education. Data collected from fieldwork underwent critical analysis to ensure the generation of valid findings.

4.6. Data analysis

The data were analysed immediately following collection, aligning with the perspectives of other researchers who emphasise that timely data analysis is essential [9, 23]. This approach is critical as it enhances the relevance and accuracy of the findings. The researchers employed the six stages of data analysis proposed by Braun and Clarke [5] as explained by Dawadi [13], which facilitate a systematic examination of qualitative data. The stages included data familiarisation, generating initial codes, searching for themes, reviewing, defining, naming, and producing a research report. All transcripts and audio recordings were organised and coded to fit the study's purpose. The analysis for developing the story was grounded in themes derived from the research objectives, ensuring minimal overlap between them.

During familiarisation, the researchers immersed themselves with the data to be familiar with it through repeatedly listening to the recordings, reading, rereading and summarising the content to understand and get the interesting meaning provided across the data set in relation to research objectives. The researchers compiled the data using different files according to their categories: interviews, focus group discussions, observation, and documentary review.

In the second phase, the researchers identified specific content segments relevant to the study. This was done by highlighting and labelling phrases of words to the most repeated and interesting words that appeared relevant to the study. The coding process dealt with the entire dataset systematically and thoroughly.

The third phase of analysis involved generating initial themes: these are central concepts developed from codes developed in the second phase. The researchers identified shared patterns of meaning across the dataset and compiled the clusters of codes that seemed to share a core idea, which provided a meaningful answer to the research objective [23]. Themes were broader than codes, and they are units of analysis that help interpret the data.

The fourth phase of data analysis involved reviewing themes. The researchers verified the themes to establish whether they make sense based on patterns of shared meanings in relation to the research questions in the dataset. The emergent themes inferred from the findings were used to draw and verify conclusions according to the research objectives and the research questions.

The fifth phase involved refining, defining and naming themes. During this phase, the researchers fine-tuned the analysis, ensuring each theme was demarcated and built around a strong core concept based on the data [32].

The sixth and final phase involved summarisation (writing up).

4.7. Trustworthiness of the research

Lincoln and Guba [41, 42] suggested four criteria for evaluating qualitative research: credibility, transferability, dependability and confirmability. Thus, those four criteria were adhered to meet the study's objectives and ensure that the findings are trustworthy.

4.7.1. Credibility

The research did several things to ensure that the findings were trustworthy and that the data were congruent with reality. First, the researcher used triangulation to ensure credibility in research findings in [69]. The researcher used methodological triangulation, which is the use of more than one method of collecting, whereby observation, interviews, focus group discussion and documentary review were used to

ensure the data collected were credible. Second, peer debriefing offered the researcher valuable external perspectives on the methodologies and findings.

4.7.2. Transferability

In order to establish the applicability of the study, transferability, which deals with the ability for the study to be applicable in other contexts after other researchers try to replicate the study, was considered [16]. Thus, this study ensured transferability was attained through the researcher's focus on generating a detailed dataset and data description. When a thick description provides a rich enough portrayal of circumstance for application to others' situations, it is usually at the behest of the local constituents. In addition, the selection of the sample and the study area was done appropriately so that the findings can also be applicable in other contexts [16].

4.7.3. Dependability

Dependability, as conceptualised by Lincoln and Guba [42], is a critical component of trustworthiness in qualitative research, emphasising the consistency and reliability of findings. It addresses whether the research process is logical, traceable, and documented, ensuring that similar results could be obtained if the study were replicated under comparable conditions [41]. In this study, dependability was achieved through audit trails, which involved a detailed description of data sources and data collection methods and techniques to demonstrate the legitimacy of the study findings. Furthermore, it was attained through prolonged engagement with the study participants and an in-depth data report so that when other researchers repeat the study, they would get the same results [69].

4.7.4. Confirmability

Confirmability in this was assured through the suggestion that using the triangulation method of data collection helped reduce the researcher bias [23]. Additionally, after data collection, a member check was used to make informants read what was said about them and check whether it matches what was written. Furthermore, frequent debriefing sessions with supervisors were necessary in order to gain their experiences on credibility issues.

4.7.5. Ethical considerations

Ethical considerations for this study included securing research clearance from the University of Dodoma. The researchers also secured permits from the Mbeya Regional Administrative Secretary and the District Administrative Secretary to conduct the study in four schools. The researchers also ensured that participation in this study was voluntary. Participants were briefed on the study's purpose, assured of confidentiality and granted anonymity before they were invited to participate in interviews and FGDs [12]. The data supporting the findings of this study have been stored securely in computer files and are not publicly available due to confidentiality and ethical restrictions concerning participant privacy. Access to the data can be considered upon reasonable request and with appropriate ethical approvals.

5. Findings

The following section presents the study's findings based on themes extracted from field data.

5.1. Science teachers' roles for enhancing girls' participation in science subjects

The study's first objective was to explore the perspectives of various stakeholders on the role of science teachers in motivating girls to learn science subjects. Through in-

terviews and focus group discussions, researchers obtained diverse views on teachers' roles in girls' science learning, including providing girls with opportunities to learn science subjects and adopting advisory roles to inspire interest in science. Additionally, teachers fostered self-efficacy by creating opportunities for active learning and using different teaching methods for girls' learning, which upgraded their knowledge for effective teaching. Other roles include teaching with commitment, evaluating and providing feedback to learners, and upgrading the knowledge. These strategies aimed to build confidence, offer tailored guidance, and involve girls in practical engagement, enhancing their participation in science education. By combining confidence-building measures with interactive teaching approaches, teachers address gender disparities and promote sustained interest in science subjects. However, the documents, including educational policy, curricula for basic education, schemes of work, and subject syllabi, do not clearly guide teachers' roles in motivating girls to learn science. This lack of clarity leaves a significant gap in understanding how educators can effectively support and encourage female students to pursue scientific knowledge.

5.2. Key roles played by teachers in motivating girls to learn science subjects

The study revealed that teachers motivate girls to engage with science subjects. Although the classes were inclusive, welcoming both boys and girls, the specific strategies and support provided by teachers were intentionally designed to enhance girls' learning experiences and outcomes in science. These targeted efforts aimed to address challenges unique to girls, fostering a more encouraging and empowering environment for their academic growth in these subjects.

5.2.1. Providing girls with opportunities to study science subjects

It has been observed that some students, particularly girls, demonstrate strong abilities and perform well in science subjects but hesitate to pursue them. This reluctance stems from societal misconceptions and stereotypes that associate science with masculine traits, leading to the belief that these subjects are inherently more difficult for females. Consequently, teachers implemented various strategies to encourage girls and challenge these misconceptions about science. A teacher from School A noted this trend.

> Even if their academic results do not meet the entry requirements, girls willing to pursue science are allowed to participate. To help them adapt, they are observed over a three-month period during which their capabilities and engagement are assessed to determine whether they can successfully continue with subjects like Chemistry. This approach is designed to encourage greater participation in science among girls by addressing potential barriers and fostering a supportive learning environment. (Chemistry teacher, School A, Interviewee 5, 17th July, 2023, Mbeya)

The previous narratives emphasised that students, especially girls, who showed interest in particular subjects received special attention and support. Another teacher explained how he created opportunities for girls to engage with his subject, stating that he actively encouraged and facilitated their learning process.

> In my classroom, I often organise group discussions to encourage students to engage with the concepts being taught. To ensure inclusivity, I make sure both boys and girls are actively involved. However, I prioritise girls' participation and presentation opportunities, as they sometimes feel hesitant to contribute, especially in mixed-gender settings. By providing them with leadership roles, I aim to foster active participation and motivation

> among the girls, helping them overcome any apprehensions they might have about speaking up in front of their peers. This approach not only promotes gender equity but also empowers girls to take on more prominent roles in the learning process. (Chemistry teacher, School D, Interviewee 16, 26th July, 2023, Mbeya)

Teachers implemented group tasks and appointed girls as leaders, fostering close collaboration with them and boosting their confidence. Additionally, teachers assured students that assistance would be readily available whenever they encountered challenging tasks. This approach was not intended to discriminate against boys; rather, it aimed to support girls, who are often perceived as shyer in classroom settings. A teacher from School A said:

> Having taught my students since they were in Form One, I have cultivated a deep understanding of their unique learning styles and needs, enabling me to engage them effectively. My teaching approach is designed to inspire those transformative "aha" moments, where students experience a surge of excitement and motivation. By fostering an environment that encourages curiosity and active participation, I aim to make biology both accessible and captivating. This connection with my students not only enhances their learning experience but also fuels my passion for teaching, as I witness their growth and enthusiasm for the subject. (Biology teacher, School A, Interviewee 7, 17th July, 2023, Mbeya)

It was revealed that the interaction between teachers and learners further facilitated mutual understanding. The study further found that it was not only teachers who acknowledged the commitment issue. Students also appreciated teachers' zeal in teaching, which made them love the subjects. A girl C3 from School C said during an FGD:

> Normal daily classes usually commence at 7:30 a.m. and conclude at 2:30 p.m. Following a short break, we return to class at 3:00 p.m., where teachers provide us with remedial instruction until 6:00 p.m. This extended period is crucial for reinforcing concepts that may not have been fully grasped during regular class hours. The structure of this schedule emphasises the importance of additional learning time, allowing us to receive targeted support and deepen our understanding of the material covered during the day. (FGD C, 27th July, 2023, Mbeya)

Participants emphasised that effective teaching hinges on the dedication of educators, which directly influences student engagement and interest in these subjects. Indeed, it appeared that teachers were committed to teaching even after the usual class time to help learners better understand the concepts. Learners appreciated and got motivated to see how their teachers cared about them by teaching them during extra time.

5.2.2. Teachers' advisory role for girls' learning

Science teachers played a crucial role in advising students, particularly girls, and thus encouraged their engagement and persistence in science subjects. This advising role begins when learners are in Form I and is woven into the fabric of daily teaching activities. These interactions often occurred in various settings, including one-on-one conversations, especially when students expressed doubts or considered giving up on their science education, classroom discussions, and meetings where teachers

emphasised the relevance of science to future career opportunities. The advice given was vital when students faced challenges in making academic decisions, such as choosing between science and art-based subjects. Thus, by addressing academic and emotional needs, teachers contributed significantly to shaping students' attitudes toward science, ultimately aiming to enhance female representation in scientific fields. In this regard, a Physics teacher from School A explained that:

> I tell learners especially girls that a background in science is likelihood to guarantee employment opportunities. The knowledge and skills acquired through science education not only prepare students for white scholar jobs but also open avenues for self-employment. This perspective fosters motivation among students to engage with science subjects more deeply. (Physics teacher, School A, Interviewee 5, 17th July, 2023, Mbeya)

This narration illustrates how teachers proactively advised learners, particularly girls, from the outset of their education. Research has confirmed that the career guidance and advisory roles provided by teachers significantly enhanced girls' understanding of the potential of science and mathematics for their future careers. This guidance is essential because it tackles the underrepresentation of girls in STEM fields compared to boys, which has led to increased female participation in science education, particularly in Schools C and D. By combining mentorship, encouragement, and targeted support that addresses the unique challenges faced by girls, this approach fosters stronger engagement with science subjects. As a result, girls are more likely to enrol in STEM courses and are better equipped to remain committed to their educational journeys in these fields.

5.2.3. The role of teachers in promoting self-efficacy to girls

Many girls perceive science as challenging and associate it with male dominance, a stereotype that negatively impacts their self-efficacy and career aspirations in STEM fields. To address these perceptions, teachers have adopted strategies to promote self-efficacy among female students, helping them build trust and confidence in their abilities. For instance, a Chemistry teacher at School D shared insights on fostering a supportive environment where girls can collaboratively engage in learning activities, empowering them to overcome stereotypes and develop a stronger science identity.

> The question-and-answer method is a teaching strategy I frequently employ, particularly when I notice that students' responses are inadequate. During lessons, I ask questions and randomly select a girl to provide an answer, rewarding those who respond correctly. This approach significantly boosts girls' motivation. By actively engaging them in the learning process, I encourage critical thinking and participation, which not only enhances their understanding but also fosters a supportive classroom environment. (Chemistry teacher, School D, Interviewee 5, 17th July, 2023, Mbeya)

This explanation revealed that many girls often avoid participating in science-related learning activities. Teachers must engage them in various activities and encourage them to build confidence in their abilities to study. Some students shared insights on how teachers can foster this confidence and motivate them throughout the learning process.

5.3. Other roles played by teachers in motivating girls to learn science subjects

The study found that teachers played other roles in promoting girls' participation in learning science subjects. Although these roles benefited both boys and girls, teachers made extra efforts to motivate and support girls, recognising the greater impact of their encouragement on female students.

5.3.1. Teaching with commitment for girls' motivation to learn science subjects

Participants explained that it takes the teachers' commitment to teach the students well to motivate them. Thus, they had to thoroughly prepare before teaching and use different motivating techniques to make learners interested in learning. Moreover, teachers needed to upgrade their knowledge to be up-to-date with the new strategies for learners' motivation. The head of School C said:

> Teachers are performing their duties wonderfully, and this acknowledgement goes beyond mere credit. Each one is mindful of the timetable and consistently arrives on time for classes. Overall, teachers demonstrate a commendable level of punctuality, distinctly contrasting with other schools where reminders may be necessary for attendance. (Head of School C, Interviewee 14, 26th July, 2023, Mbeya)

The statement emphasises the positive impact of teacher punctuality on girls' motivation to learn science subjects. It asserts that teachers are dedicated and consistently arrive on time for their classes, which sets a standard for student behaviour and contributes to a structured learning atmosphere. Another teacher from School A said:

> I strive to teach my students in a way that leads them to those 'aha' moments, where they feel a surge of excitement and motivation. Having taught these students since they were in Form I, I have developed a deep understanding of their learning styles and needs, which enhances my ability to engage them effectively. (Biology teacher, School A, Interviewee 7, 17th July, 2023, Mbeya)

It was revealed that the interaction between teachers and learners further facilitated mutual understanding.

5.3.2. The use of teaching methods for girls' motivation to learn

Teachers employed both teacher-centred and learner-centred methods indiscriminately to teach science subjects to boys and girls. However, they deliberately tried to motivate girls due to their underrepresentation in these fields. Commonly used strategies included the lecture method, group discussions, hands-on activities, and laboratory experiments. These approaches aimed to enhance girls' engagement in science. One Biology teacher had the following to say during interviews:

> Girls often find certain subjects challenging due to the theoretical approach used in teaching, particularly through the lecture method. This method can make it difficult for students to grasp abstract concepts, leading to low motivation. In contrast, practical methods allow children to visualise what they are learning, which not only motivates them but also aids in better retention of the information. By incorporating hands-on experiences, students can connect theoretical knowledge with real-world applications, making learning more engaging and effective. (Biology teacher, School D, Interviewee 16, 26th July 2023, Mbeya)

The lecture method of teaching was preferred by teachers, especially in schools A and B. The method involves teachers explaining concepts while learners listen attentively, most of the time during classroom sessions. It is a traditional way of teaching based on a teacher-centred approach, which does not promote critical thinking and rarely engages learners in teaching and learning. In classrooms, researchers observed some teachers teaching using the lecture method. However, recognising the limitations of

the traditional methods, teachers employed more interactive approaches, such as group discussions, to address the gender gap. As described by one Biology teacher from School D:

> I like to engage them in learning to make them participate in all activities [participatory methods]. I rarely talk; I just provoke the topic, then they discuss. Thus, the discussion may be in groups or in pairs. I sometimes use videos to show them something to be discussed. For example, now I am teaching about 'hormonal coordination' because there are things which cannot easily be seen, because they are inside the bodies, then we went to the staffroom and I put the video in relation to that, and it helped them to understand. (Biology teacher, School D, Interviewee 18, 26th July, 2023, Mbeya))

Teachers actively engage girls in group work, enhancing their critical thinking skills and providing a platform for them to articulate their ideas, interact with peers, and develop leadership skills. Furthermore, they utilise laboratory sessions and practical activities to deepen students' understanding of scientific concepts. These hands-on activities are a powerful motivational tool, inspiring girls to pursue science subjects. By fostering a supportive and interactive learning environment, teachers encourage girls to explore their potential in science, ultimately empowering them to pursue careers in these fields with confidence and enthusiasm. A respondent from the Chemistry department emphasised that these practical sessions not only enhance learning but also ignite interest among girls in STEM fields.

> When teaching students about the rate of reaction, I find it essential to conduct practical demonstrations in the laboratory. This hands-on approach allows them to visualise and understand complex concepts more effectively. For instance, I demonstrate both reversible and irreversible reactions to help them grasp the differences. To illustrate irreversible reactions, I use the example of magnesium reacting with hydrochloric acid. By showing how magnesium dissolves when placed in hydrochloric acid, students can see firsthand that the reaction cannot be reversed. This practical confirmation of theoretical concepts often fills students with excitement and satisfaction, as they witness the tangible evidence of what they had previously learned in theory. (Chemistry teacher, School D, Interviewee 16, 26th July, 2023, Mbeya)

The emphasis on laboratory-based learning aligns with the broader context of scientific innovation, where experimentation plays a crucial role in understanding and applying scientific principles. One Chemistry teacher in School D made the following comment.

> Hands-on activities motivate learners in unique ways. For example, in teaching acid-base, I ask students to mix the acid, base and salt and determine indicators on their own. The following day, I asked them to observe and test colour changes when mixing acids, bases, and salts. Such activities serve to motivate and engage students in the learning process. (Chemistry teacher, School D, Interviewee 6, 17th July, 2023, Mbeya)

Hands-on activities motivated learners to learn and gain skills needed for socio-economic development. Cognitive and competency skills are enhanced through the use of empirical evidence when learners get involved in real activities. The study

found that hands-on activities also enhance the recall of information. However, the researchers observed that schools A and B had no science laboratories for practical experiments. Teachers in these schools did all experiments in normal classrooms, which were not designed for practical use. This situation posed a challenge in engaging girls in practical activities and motivating them to learn science subjects. Teaching science involves making students learn by doing, touching and seeing what was done in the actual learning process.

5.3.3. Evaluation and providing of feedback for girls' motivation

The study found that teachers were crucial in evaluating students and providing constructive feedback after assignments and examinations. This feedback served multiple purposes: it helped students recognise their strengths and weaknesses, motivated them to improve, and enhanced their learning experience. The academic master from School D said:

> We have been displaying their results on the notice board so that they can see what they have done. Each student can see the results of fellow students. Those who have performed poorly would feel bad to be exposed to others and would likely strive to change. (Academic master, School D, Interviewee 14, 26th July, 2023, Mbeya)

Some students were motivated by the evaluation and feedback to pursue science and mathematics. A student C6 from School B explained:

> Most of our science teachers use common methods such as group discussion. They leave us with assignments or quizzes then later on they come to check if we did well. They then ask us to do corrections for the ones we performed poorly. Thus motivating use to learn and improve our learning. (FGD D, 18th October, 2023, Mbeya)

It was well understood that teachers' evaluations help students know their weaknesses and abilities, thus motivating them to study harder, especially for those who performed poorly. The practice of displaying student results on a notice board serves multiple educational purposes, particularly in fostering accountability and motivating students to improve their performance. As highlighted by an academic interview on July 26, 2023, this approach reflects a broader strategy in educational environments to enhance student engagement and learning outcomes.

5.3.4. Upgrading knowledge

The study highlighted teachers' need to develop diverse skills to motivate students, particularly girls, to learn science effectively. It was found that enhancing teachers' knowledge through seminars and workshops significantly contributed to their ability to engage female students in scientific subjects. The Biology teacher from School D emphasised the importance of these professional development opportunities, stating that they equip teachers with various teaching techniques tailored to foster girls' interest in science. In this connection, he said:

> Professor Adolf Mkenda, Tanzania's Minister of Education, has demonstrated commendable efforts to improve the country's education sector. His initiatives include organising seminars that equip teachers with essential teaching methodologies and skills, ensuring they remain effective in their roles. These seminars serve as a valuable reminder for teachers, helping them refine their practices and adapt to evolving educational needs. These

> seminars are instrumental in equipping them with essential skills that enhance learners' motivation. (Biology teacher, School D, Interviewee 18, 26th July, 2023, Mbeya)

The government has taken significant steps to enhance the professional development of teachers, providing them with various opportunities to upgrade their skills and knowledge. Such seminars for teachers help remind the teachers about different things, especially about value-adding teaching methods that facilitate the motivation of girls taking science to learn.

5.4. Challenges that teachers face in their efforts to improve girls' participation in science

Despite teachers' best efforts to engage girls in science education, various challenges impede their success, hindering teachers' ability to facilitate effective learning in science. Resulting in difficulties in teachers' efforts to make girls effectively learn science. Among the most significant obstacles are poor infrastructure, overcrowded classrooms, and scarcity of resources, which hinder effective teaching and limit opportunities for hands-on learning experiences. Additionally, challenges stemming from the students themselves exacerbate the issue. Many girls hold incorrect perceptions about science and lack confidence in their abilities, negatively impacting their engagement and performance. Addressing these barriers requires systemic improvements in educational facilities and resources, alongside targeted interventions to reshape girls' attitudes towards science and boost their self-confidence.

5.4.1. Poor infrastructure for effective teaching

The researchers observed the situations in schools A and B with poor learning infrastructure for studying science subjects. The schools had inadequate water and poor sanitation, causing learners, especially girls, to suffer, leading to irregular attendance and drop-outs. In other words, some of the challenges had more effects on girls than boys due to their biological nature. During interviews in School A, the Physics teacher made the following remarks:

> Motivating girls to learn science subjects is challenging due to an unfavourable environment that hinders their academic progress. The school lacks adequate water, proper toilets, and well-equipped laboratories, which negatively impact girls' learning experiences, particularly during menstruation. Insufficient water and poor sanitation facilities make it difficult for girls to manage menstrual hygiene effectively, leading to absenteeism during their menstrual cycles. Additionally, the laboratories used for science lessons were originally designed as classrooms, limiting their functionality for practical experiments. These infrastructural shortcomings contribute to the broader issue of gender disparity in science education, as girls face compounded challenges, including socio-cultural biases and inadequate resources that discourage their participation in STEM fields. (Physics teacher, School A, Interviewee 2, 21st July, 2023, Mbeya)

During data collection, it was evident that girls faced poor infrastructure as they participated in science subjects. The researchers observed some teachers in schools A and B sitting outside in the sun because of cold weather, especially during early morning periods.

5.4.2. Overcrowded classrooms

The researchers found that some schools had large classes compared to other schools. Large classrooms had adverse impacts on maintaining pace and speed of

learning versus understanding on the part of the students. Describing the situation in some of the schools, the Biology teacher from School C explained:

> Overcrowding in classrooms poses significant challenges for teachers, particularly in providing individualised support to students. The lack of adequate teacher-student interaction, compounded by overcrowding, limits opportunities for personalised attention and exacerbates the challenges faced by students who already feel marginalised or hesitant to contribute. This dynamic not only affects learning outcomes but also perpetuates gender-based disparities in classroom participation and confidence. (Biology teacher, School C, Interviewee 13, 18th July, 2023, Mbeya)

The surge in enrolment in community secondary schools, driven by the expansion of education following the implementation of the free basic education policy, has led to significant classroom overcrowding. This situation poses challenges to effective teaching and learning, as the large class sizes hinder teachers' ability to interact fully with girls and their peers, ultimately diminishing their motivation and engagement in the learning process.

5.4.3. Scarcity of teaching facilities

The study highlights critical challenges community schools face, particularly the severe scarcity of teaching facilities, which negatively impacts teachers and students, especially girls learning science subjects. Respondents emphasised that inadequate resources, such as insufficient science textbooks, hinder effective teaching methods. One respondent from School D noted this issue during interviews, underscoring the need for better infrastructure and resources to support science education:

> We experience challenges during teaching due to the scarcity of textbooks. Textbooks are generally insufficient. (Academic master, School D, Interviewee 14, 26th July, 2023, Mbeya)

According to the respondents, it was not easy for science teachers to motivate girls to learn science in such a situation. Lack of enough resources caused learners to share the few resources available, such as books. It was hard for teachers to effectively engage all learners in learning activities with few resources. A scarcity mindset among teachers, stemming from resource deficits, can impair cognitive and behavioural effectiveness in teaching, further exacerbating the problem.

5.4.4. Girls' embracing bad influence from others

The study's findings revealed that girls experienced a bad influence from society, such as peers, parents, teachers and others who gave them wrong information concerning science subjects. The society tend to believe that the subjects relate more to masculine gender and are hard for girls. This wrong perception has a bad implication for girls since they tend to believe that science subjects are harder than other subjects. Teachers may unconsciously stereotype girls as less capable in science and math, attributing their success to effort rather than innate ability. Such biases can discourage girls from pursuing science further. A Biology teacher from School C had this to say:

> Many female students hold preconceived notions that science subjects are inherently difficult, creating a psychological barrier to learning. This belief, often based on prior experiences or societal perceptions, significantly reduces their motivation when engaging with science coursework. The perception of toughness overshadows their learning process, leading them to

> approach these subjects with a diminished sense of capability and interest. It takes a lot of energy for a teacher to change girls' wrong perceptions. (Biology teacher, School C, Interviewee 12, 18th July, 2023, Mbeya)

It was learned that societal influences can significantly impact girls' perceptions and attitudes towards science subjects, often leading to negative biases and a skewed understanding of their capabilities in these fields. These detrimental influences can foster self-doubt, limit girls' interest, and ultimately discourage girls from pursuing scientific studies and careers, perpetuating a cycle of underrepresentation in STEM.

5.4.5. Girls' lack of confidence in learning

The results indicated a disparity in confidence levels between girls and boys in science education, with girls often exhibiting less confidence. This difference may stem from girls' negative attitudes, perceiving science subjects as inherently more challenging, undermining their self-assurance and engagement in these fields. A Biology teacher from School D explained:

> Within the classroom setting, a noticeable disparity exists in the confidence and willingness of girls to participate actively in answering questions. Many girls appear to grapple with an inferiority complex, which hinders their ability to engage confidently with the material and articulate their understanding. This fear of being wrong or judged often silences them, limiting their participation in the learning process. Consequently, this dynamic presents a significant challenge for teachers, as it affects teaching effectiveness and the equitable involvement of students in academic discussions. (Biology teacher, School D, Interviewee 13, 18th July, Mbeya)

The study found that most girls tend to shy away from learning science subjects compared to boys. Moreover, they perceive themselves as weaker than boys and tend to believe that science fields are meant for boys and not for them [2].

6. Discussion of findings

The study revealed that the participation of girls and women in STEM can be improved if teachers effectively play their role of motivating students, particularly female students, starting from an early age to develop a positive attitude towards science subjects [71, 78]. Teachers play a multifaceted role in motivating girls to learn science subjects. These roles include teaching with commitment, which involves thorough preparation, evaluation, and providing constructive feedback to learners. Teachers also serve as advisors, promoting self-efficacy among students by encouraging confidence and active participation. Additionally, they continually upgrade their knowledge to create engaging and effective science lessons. These efforts were particularly impactful in schools C and D, where they significantly improved girls' participation in science subjects. By employing strategies such as learner-centred teaching methods, group discussions, hands-on activities, and lab practical experiments learning, teachers were able to address gender disparities and foster a positive learning environment. Despite challenges like overcrowded classrooms and inadequate resources, these roles and methods effectively motivated girls to pursue science education.

The findings are consistent with prior research. For example, Manurung [45] highlights the importance of thorough preparation by teachers before teaching, as it plays a crucial role in fostering students' affective, cognitive, and psychomotor skills, enhancing their motivation to learn. Similarly, Nwafor [59] underscores the significance of teaching commitment, particularly in encouraging girls to engage with

science and mathematics actively. In contrast, Mwesiga [52] observed that many teachers in Tanzania lack commitment to their teaching responsibilities.

The study revealed that schools lack specialised teachers trained to provide career guidance services to learners. Consequently, science teachers often advise girls about the importance of studying science subjects and their future career prospects in relation to these subjects. Shuma and Gwajekera [68] emphasises the significance of guidance and counselling services in supporting girls' choices in STEM education, aligning with the study's findings. However, Zainudin et al. [82] argues that school counsellors should primarily be responsible for advising secondary school students on career decisions. This discrepancy underscores a gap between the expected role of counsellors and the observed practices in schools. Addressing this gap is crucial for effectively guiding girls toward STEM careers and ensuring they receive adequate support tailored to their aspirations.

Similar to the findings of Zainudin et al. [82], the importance of teachers actively seeking opportunities to enhance their knowledge and skills cannot be overstated, particularly in fostering student interest in science. By staying updated on innovative practices and methodologies, teachers can inspire and motivate learners more effectively, leading to improved academic performance in science disciplines. This proactive approach addresses the declining interest in science education and helps students understand its relevance to their future careers. Integrating these roles into teaching practices ensures that educators remain equipped to connect theoretical concepts with practical applications, cultivating scientific literacy and critical thinking among students.

However, teachers face significant challenges despite their efforts to motivate girls in science learning. These include poor infrastructure, scarcity of teaching materials, negative influences on girls, and a lack of confidence among female students regarding their ability to excel in science. Such barriers present difficulties in fostering gender equity in science education, emphasising the need for targeted interventions to support both teachers and students in overcoming these obstacles

STEM education thrives on practical, hands-on activities that engage students in laboratories or through technology. However, poor infrastructure, including inadequate lab facilities, outdated equipment, and insufficient computer access, hampers teachers' ability to deliver interactive lessons. This results in abstract teaching methods that fail to capture students' interest, particularly among girls who often perceive STEM subjects as challenging. Matete [47] highlights this issue in Tanzania, where science and mathematics teachers predominantly teach theoretically due to insufficient laboratories in public secondary schools. Such disengagement negatively impacts student motivation and academic performance, underscoring the need for improved resources to foster experiential learning and make STEM education more accessible and inspiring.

7. Conclusion and recommendation

Teachers play a pivotal role in motivating girls to pursue science subjects, and their effectiveness can be enhanced through targeted support and resources. To address this, the study recommends several actions for key stakeholders: the government should improve science teaching and learning environments by modernising school infrastructure, providing adequate teaching materials, and fostering supportive environments. Additionally, it should offer professional development opportunities for teachers to equip them with inclusive and innovative teaching strategies. Schools should also have sufficient counsellors to guide girls on science-related issues and future careers. Furthermore, the government must collaborate with society to address

stereotypes discouraging girls from pursuing science subjects.

Curriculum developers are urged to create documents that clearly outline the role of teachers in motivating girls to pursue science, incorporating principles of inclusive education and fostering interest in science among girls to address the underrepresentation in these fields. This includes integrating learner-centred approaches such as group discussions, hands-on activities, and demonstrations that actively engage students. Teachers are encouraged to adopt positive attitudes towards girls and science, actively motivating them through inclusive teaching methods and fostering collaboration with society to spark interest in science subjects. They should adopt diverse strategies to motivate girls in science, such as assigning leadership roles during group work, using practical experiments, and employing gender-sensitive language emphasising action. They should also act as role models and actively challenge gender biases.

The society must work towards dismantling stereotypes about girls in STEM fields by promoting awareness campaigns and showcasing successful female role models in science. Finally, girls should be encouraged to participate actively in science activities through supportive environments that build their confidence and interest in STEM subjects. Furthermore, they are advised to shift their mindset towards science education, fostering a cooperative effort where teachers play a pivotal role in inspiring and guiding them. These measures collectively aim to bridge the gender gap in science education and promote equitable participation.

The study's findings are not broadly applicable to the entire country due to their limitations. Specifically, the research was confined to four community secondary schools in the Mbeya Region, involving a small sample size of only 40 participants. Such a narrow focus restricts the ability to generalise the results effectively, as a limited sample may not accurately represent the larger population. Consequently, while the study provides valuable insights into the specific context of these schools, it cannot be used to form a comprehensive understanding of educational issues across Tanzania. Researchers propose that future studies employ a larger sample size with more comprehensive coverage. They recommend expanding the scope of research to include both public and private secondary schools. This broader approach would provide a more diverse perspective, contributing to a deeper understanding of the subject matter by capturing a wider range of experiences and insights.

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A. Interview guide for Science and Mathematics teachers

Part A: Invitation to the study

Dear teacher, I am pleased to invite you to participate in this research focused on promoting girls' participation in science education: a Tanzanian secondary school's perspective. This study is part of my PhD program at the University of Dodoma and aims to address the challenges of low motivation and participation among girls in

Science. By enhancing their engagement, we can contribute to building a stronger future workforce in STEM careers, ultimately supporting national development. Your insights and experiences are highly valued and will be treated with utmost confidentiality. No personal identifiers, such as names, will be included in the research report. Additionally, your participation is entirely voluntary, and you are free to withdraw from the study at any point if you feel the need. I deeply appreciate your cooperation and look forward to your valuable contributions to this important endeavour.

You are welcome.

Part B: Personal particulars

1. Sex
2. Level of education
3. Professional qualification
4. Location

Part C: Interview questions

1. How long have you been teaching this subject in this school?
2. How motivated are girls to learn this subject?
3. To what extent does the learning environment support girls learning science subjects?
4. What can be done to improve the situation of girls in science?
5. What is your role in motivating girls to learn science subjects?
6. Which teaching methods do you use to motivate girls to learn this subject?
7. How do you treat girls during teaching to motivate them to learn science subjects?
8. What challenges do you face when helping girls participate in learning?
9. What should be done to help overcome girls' challenges in science?
10. How should the government support efforts to motivate girls to learn science subjects?

B. Focus group discussion for Science students

Part A: Invitation to the study

Dear girls, I invite you to participate in a research study focused on promoting girls' participation in science learning in Tanzania. This study is part of my PhD research at the University of Dodoma and aims to address the challenge of poor motivation among girls in science education. The findings will contribute to identifying effective measures that the government can implement to improve the situation and foster greater engagement of girls in science subjects within secondary schools across Tanzania.

You are welcome.

Part B: Personal particulars

1. Gender
2. Cohort
3. Name of school

Part C: Questions: topical issues for discussion

1. What factors influenced your decision to select science subjects?
2. How supportive were teachers during your decision-making process?
3. What challenges do you face as you learn science subjects?
4. How do teachers engage with you to make learning interesting?
5. Which teaching methods do teachers use to make learning interesting?

6. What environmental challenges do you think teachers face during teaching?
7. How do teachers manage the learning environment to motivate students to learn science?
8. How do teachers use instructional materials to motivate you to learn those subjects?
9. What do you think are teachers' roles in helping you learn?
10. What more do you think teachers should do to help motivate you in learning?