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WHY ARE WOMEN UNDER-REPRESENTED IN STEM IN HIGHER EDUCATION IN TANZANIA?

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Abstract

Women's underrepresentation in Science, Technology, Engineering and Mathematics (STEM) has been documented worldwide. This study investigated the factors underlying women's underrepresentation in STEM in higher education in Tanzania. The study employed a qualitative research approach that was informed by historical design. Data were collected through a systematic literature review and analyzed using a content analysis. Drawing from the literature, the study findings indicate that a lack of women's participation in STEM is due to both socio-cultural and psychological factors. Sociological factors indicate that a patriarchal system and male dominance perpetuate gender inequality in STEM. Findings also indicate that cultural myths and beliefs that the science field is hard and that women are incapable of handling masculine activities hinder women from participating in science-related fields. The findings indicate further that a lack of laboratories in Tanzanian secondary schools force teachers to teach science subjects by using theories as an alternative to practical instruction. From a psychological point of view, evidence suggests that a lack of confidence among female students themselves regarding performance in science subjects hinders them from participating in STEM fields. It is recommended in this paper that if Tanzanian female students are to participate in science-related subjects in Higher Learning Institutions (HLIs), the government needs to orient them towards science subjects at the primary school level for them to build up an interest in science-related subjects. In addition, the training of science teachers remains imperative.

Keywords: Higher education; women representation; science field; science subjects; science teachers

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Women's participation in the science field has been a concern of many governments of the world (United Nations Development Program [UNDP], 2019; Christie, O'Neill, Rutter, Young & Medland, 2017; United Nations Educational, Scientific & Cultural Organization [UNESCO], 2011). Social cries have been heard around the globe that women have been under-represented in the field of science and engineering in higher education (Breda & Ly, 2012; Corporate Planning & Policy Division, 2017). It has been frequently reported that women step out of the study of science-related fields after university studies while males remain (Wiley Online Library, 2016). According to Wiley Online Library (2016), it is also obvious to find that women are under-represented in STEM related industrial and academic leading positions. These untapped fully trained and potential women, who could be interested to pursue STEM opt for not joining the field and sometimes they change their careers because of obstacles emanating from their sociological and/or psychological grounds (Castillo, Grazzi, & Tacsir, 2014).

In 2000 the European countries had 40 percent of women in Natural Sciences and Japan had only 20 percent of women in the same field (UNESCO, 2011). In the same year according to UNESCO, women's participation in Science Education and Technology (SET) industries was as follows; Europe had 15 percent, the United States of America (USA) had 19 percent while Japan had only 6 percent. In the USA, only a quarter of the workforce with a background in STEM is women (Breda & Ly, 2019). Estimates indicate that fully 90 percent of future jobs will require some forms of information and communication technology (ICT) skills, and the fastest-growing job categories are related to STEM (Smith, 2019). Nevertheless, in 2011 in the European Union countries, only 15 percent of full professors were women and rarely few women were found in engineering fields (UNESCO, 2011).

According to Castilo *et al.* (2014), countries with higher proportions of graduates in STEM tend to grow faster in terms of socio-economic development than in other disciplines. This career impediment for women deprives societies of their scarce Human Resources (HRs) and it is detrimental to the global labor force, competitiveness, and development (Castilo *et al.*, 2014). Indeed, as Mukhwana, Abuya, Matanda, Omumbo, and Mabuka (2020) state, across the globe, women and girls have not been utilized to their full potential. The world misses the exploitation of the potential female scientific talents, especially when considering their contribution to science-related field advancement (Smith, 2019).

Women's underrepresentation in STEM has been heavily debated and indeed it has been a problem in many countries of the world. See the discussion for example, from Castilo *et al.* (2014), Ekine and Abey (n.d.), Mukhwana, *et al.* (2020), Smith (2019), and UNESCO (2011). While sociological (cultural beliefs) and psychological factors have been so much associated as the main sources of the problem; previous literature concentrated at the secondary educational level. Most scholars from Tanzania also focus on factors that hinder teaching and learning in science-related subjects in secondary schools in general, but they do not point out the difference between female and male students' involvement in science-related subjects. See writers for example, Buhatwa (2014) and Bryat (2014), Mehta (2012), Mupa and Chinooneka (2015), Nyanda (2011), Projest (2013).

A study by Bipa (2010) in Tanzania focused on women's participation in science education in Higher Learning Institutions (HLIs), but it was confined to the Dar es Salaam Region only and it has been so long up to now since the study was carried out. Thus, much is still desired to be done regarding women's under-representation in science-related fields in higher education in Tanzania. This paper discusses the factors behind women's

underrepresentation in the science-related field in Tanzania and provides a framework that can guide the early involvement of girls or women in STEM-related subjects. It is hoped that if girls are engaged in STEM during their early ages, it is not only possible to inject in their minds positive thinking in science subjects but also to prepare this potential segment of the population for societal development. The research question in this study was: Why are women underrepresented in the science field in higher education in Tanzania? The assumption in mind was that there might be women representation at lower levels of education, but if they are not represented at higher levels then, the science field is likely to suffer the consequences as there shall be no spillover effects to the lower levels of education.

Rationales for Women to Engage in Science Subjects

The rationales for women's participation in science subjects are multiple. Few of these rationales include: the improvement of livelihood and health of an individual and the nation; improving science and technology and empowering women to take a stage in science subjects as indicated here under:

Improve Livelihood and Health at Individual Level and Nation

Women scientists play a critical role in national development particularly in Africa and they are the ones to push the development for gender equality in their societies (Dasgupta & Stout, 2014; Zacharia, Hovardas, Xenofontos, Pavlou & Irakleous, 2020). There is a notion that if you educate a woman you have educated the whole family and the society at large. In many societies, women are the ones responsible for taking care of the children. Thus, they are more likely to improve the health of the family including the provision of a balanced diet to their family members. Indeed, science education has been recognized to improve livelihood and has been regarded as an important instrument for the advancement of socio-economic development all over the world (Bipa, 2010; Zacharia *et al*., 2020). Persistence inequality, limits women to participate fully in the development of the country and it hinders them from achieving their potential contribution to the economy (Castillo et al., 2014). According to Ekine and Abey (n.d.), any country that tends to neglect the provision of a good quality science education to its citizens may find itself a dumping place for other innovations without potential human resources that can sustain competition in the global marketplace.

Improve Science and Technology

There is no doubt that science and technology are vital and that they play an important role in sustainable development. It is widely acknowledged that in this globalized world, scientific innovation is necessary for a country's economic competitiveness, quality of life, and national security (Dasgupta & Stout, 2014, Kuschel, Ettl, Diaz-Garcia & Alsos, 2020). Higher education and education, in general, have been acknowledged to promote tolerance, democratic and political awareness, and respect for human beings (Bipa, 2010). According to Ekine and Abey (n.d,), gender equity is a very important factor that enhances social development. For a country to secure good health for its people so that they fight against diseases and that they protect the environment which is an essential asset for food production, it needs scientific knowledge and skills.

Nevertheless, increased industrial development and innovations in science and technologies and skills rely on STEM-related fields (Dasgupta & Stout, 2014; Ekine & Abey, n.d,). According to Castilo *et al.* (2014), women tend to be deprived of the societies' scarce human resources which in turn tend to be detrimental to the competitiveness and

development of the society itself. To Iwu and Azoro (2017), Technology and Science Education (TSE) is very important for both men and women to accelerate the pace of socio-economic development in the world. As observed by Iwu and Azoro, Science, Mathematics, and Technology (SMT) are the foundations for bringing immense wealth and for improved quality of life including the ability of an individual to interpret the world.

Empowering Women to Take the Stage in Science Subjects

Higher education for women enables them to be confident and be able to participate in science-related subjects. They may also be able to involve themselves in political issues such as involving themselves in elections and/or competing and contesting for various positions as men do. Some women have been contesting for parliament membership seats and some have even contested for a presidential position. The UN Global Compact (2010) gives several principles for empowering women if they are to participate in science subjects as follows: First, there should be an establishment of the high-level cooperation between administrative leadership in schools and the universities on issues related to gender; Second, there is a need to have a fair treatment of all women and men at work, i.e. to respect and support human rights and stand against all types of discrimination; Third, in workplaces, there must be an assurance that all women and men as workers have good health, secured and have acceptable well-being; Fourth, there should be an introduction of training and professional development programs for women to equip them with knowledge and skills that awaken them to create their identity and their place in the individual, family, and national development in its totality. Fifth, there should be an implementation of the enterprise development activities, supply chain, and marketing practices that empower women to take part in science subjects and that they consider themselves as capable. Sixth, there should be a promotion of equality among men and women through community initiatives and advocacy activities; and seventh, is equally important that there are measurement and evaluation of the progress made by this segment group and there should be the provision of a public report to achieve gender equality in STEM.

Status of Women in STEM Worldwide

At a global level, Germany had 50 percent of women enrolment in bio-engineering science in 2000. In the USA, women and girls comprised 50 percent of the population and had more than 50 percent of the college-bound population (UNESCO, 2011). If this segment could have been well utilized, it could have enhanced the STEM workforce and contributed to national development. Unfortunately, they seem to be an untapped human capital in the STEM workforce (Dasgupta & Stout, 2014). Yet, the untapped potential of fully trained and credentialed women who might be interested in the STEM field choose to pursue degrees in other fields, and sometimes they decide to change their careers which is a lost opportunity not only for the women themselves but also to the nation as a whole (Castillo *et al*., 2014).

While the gap between girls and boys in STEM seems to exist in both developed and developing countries, the problem appears to be more serious in developing countries. In the African region and particularly in sub-Saharan African countries, a wide gender gap has been persisting over the years at all levels of STEM disciplines throughout the world (Castillo, *et al*., 2014). Women continue to lag behind men in STEM and in the employment scene that involves science-related fields and in most cases, women scientists are fewer than men in STEM industries (UNESCO, 2011; Mukhwana, *et al*., 2020). Countries that are recognized as highly developed or labeled as industrialized world such as that of the USA,

Latin America, United Kingdom (UK), Canada, and Japan still experience women under-representation in STEM (Breda & Ly, 2012; Corporate Planning and Policy Division, 2017; Wiley Online Library, 2016). Women are discouraged or even discriminated against by professors when they choose to study science at the university level (Breda & Ly, 2019). Before the 19th century, in the USA, there was an under-representation of women in STEM and with only a small percentage of engineers (UNESCO, 2011). This is what raised the feminist movement at that time as women were dissatisfied with such oppression (Evans, 2015; Binard, 2017).

Some Efforts to Improve Women's Participation in STEM at a Global Level

There have been various efforts to improve women participation in STEM, including the creation of women platforms such as that of the Beijing conference of 1995, the UNESCO world conference on Science (WCs) in 1999, and the Convention on the Elimination of Discrimination against Women (CEDAW) in 1979 at international level (UNESCO, 1999; UN, 1995). Again, the United Nations Millennium Declaration (UNMD) member countries vow to promote gender equality and empowerment of women as effective ways to combat poverty, hunger, and diseases and to stimulate truly sustainable development (Ekine & Abay, n.d.). It has been believed that gender balance is more likely to facilitate more equitable recruitment of the most talented people within the STEM-related field (European Commission, 2008).

Other initiatives include the introduction of Africa's Science and Technology Consolidated Plan of Action (ASTCPA) in 2006, as a high-level integration platform for the development of policies and setting priorities on Science, Technology and Innovation [STI] (Ambali, 2008; Kahn, 2008). It also provides political and policy leadership for the implementation of the Consolidated Plan of Action [CPA] for African countries (African's Science & Technology Consolidated Plan of Action, 2015). Recently, in 2015 the United Nations adopted the Sustainable Development Goals (SDGs) to be achieved by 2030, and education for females' agenda is at the center (Jatana & Currie, 2020). There have also been some efforts to introduce the Southern African Development Community (SADC)'s Gender Policy to support equal access for girls and boys to Science and Mathematics education. This includes the promotion of women and girls' access to higher education in non-traditional subject areas by encouraging the involvement of women in science-related studies (Ekine & Abay, n.d.). Other efforts include the introduction of the Economic Community for the West African States (ECOWAS) that supports the contribution of women in the STI field (ECOWAS, 2015; UNESCO, 2017).

In East African countries, however, data of 2009 indicate low enrolment in science subjects both in Kenya and Uganda (UNESCO, 2011). In Tanzania, women tend to enroll in Humanities and Arts and other social sciences as opposed to natural sciences, engineering, and technology (UNESCO, 2011). Even when female students' performance could be as good as that of their male counterparts on STEM examinations or being even better, female students tend to lose interest and do not pursue STEM-related courses in their university education (Dasgupta & Stout, 2014). In Tanzania, the survey of 2009 indicated that among the 1,345 women graduates in SMT disciplines only 44 percent were employed in research and development (UNESCO, 2011). The Tanzania Education Policy of 2014 indicates the ratio for primary education for boys and girls to be approximately 1:1, for secondary education is 1:0.9 and for higher education is 1:2 (URT, 2014). This problem has been associated with poor participation of students in STEM at the university level including women. Yet, these data comprise all fields of studies at Higher Learning

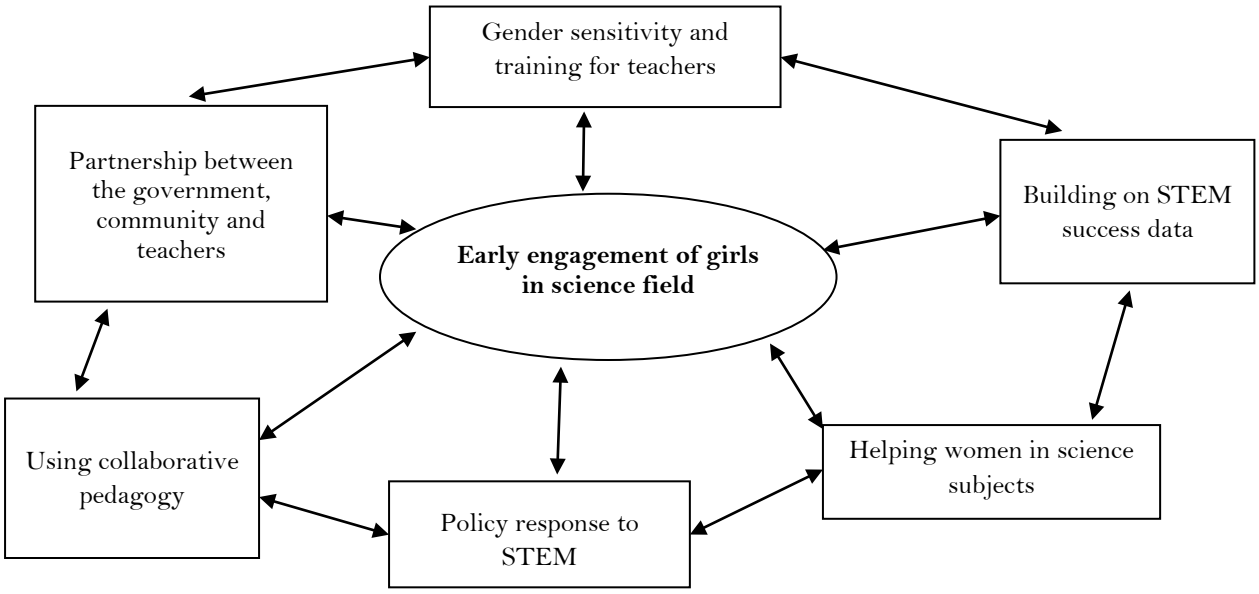
Institutions (HLIS), while science continues to suffer as many girls opt for Arts courses for the university education (UNESCO, 2011). The gap that exists in STEM may weaken the innovation potential of society in terms of economy (Castilo *et al.*, 2014).

A Framework for Effective Involvement of Women in STEM

For effective women's involvement in STEM, there are some interplay strategies that need to work together (see the Figure below). Early intervention may improve the participation of girls in STEM starting from primary schools, continuing to secondary schools, and to the HLIs. The following are some strategies that are thought to be critical: Early engagement of girls in the science field; policy response, helping women in science, building on STEM, gender sensitivity and training for teachers, the partnership between the government, community, and teachers and using collaborative pedagogy. Double directional arrows indicate the relationship that exists between the components for helping the girl child to build confidence in science-related subjects to ensure that there is a collaboration of all actors such as policymakers, curriculum developers, community members, the government, teachers, and educational activists. These mechanisms or efforts are elaborated further as follows:

Figure 1

A framework for improving girls' participation in the science field



Source: Adapted from Ekine and Abay (n.d.)

Policy Response to STEM

For effective women participation in STEM, a policy response is required. Pupils in primary schools have to be taught that women can perform better as males do in science-related subjects. The teachers have to take a lead to encourage young girls to have confidence and trust in themselves that they can excel at advanced levels. At the secondary school level, girls are to be encouraged to opt for science-related subjects. The government has to endure that schools are furnished with laboratories with chemical apparatus so that

girls practice what they learn through theories that can facilitate their confidence and competence in science-related subjects. Such confidence may ultimately help them continue with science specialization in Higher Education Studies (HESs).

Helping Women in Science Subjects

There must be some efforts and programs that focus on helping women by involving them in science subjects including using media sensitization to make a woman aware of what roles she can play in society to improve participation in STEM.

Building on STEM Success Data

Make sure that evaluation is carried out and data are well kept including disseminating the findings to encourage women to engage in STEM. Provision of some incentives that could encourage women and girls towards positive thinking that they are capable as males when it comes to STEM subjects is also important. This can be done by using the women who have success stories in the science field to encourage and help women to opt for science subjects.

Gender Sensitivity and Training for Teachers

It is important that gender-related issues are stressed from the primary school level and that teachers are trained to sensitize their pupils to know their position in society and take a lead when it comes to STEM-related subjects. This can be done by using different advocacy and sensitization programs in order to encourage women and girls to involve themselves in STEM-related subjects. At the same time, it will be important to help girls eliminate their negative cultural beliefs. Men are also encouraged to value women at the family level and at the community at large.

Partnership between the Government, Community, and Teachers

Parents have to take a lead in making sure that their children are not alienated from STEM and that the Government has some training programs to ensure that there is a partnership between the school and the community. Parents have to be careful in identifying the talents of their children at a very tender age including supporting their children to learn at home. The Government through its Ministry of Education, Science, and Technology (MoEST) needs to offer more scholarships in STEM-related subjects so as to encourage girls and women to advance themselves and pursue their studies in STEM.

Using Collaborative Pedagogy

Using teaching and learning pedagogical techniques that encourage women to build their self-esteem where girls are given an opportunity to give out their views such as that of learner-centered methods and Socratic methods. These techniques may encourage them to be confident and have the opportunity to ask questions. They also need to be given some assignments that force them to use the library materials to challenge their own minds and widen their knowledge and skills through inquiring minds and critical thinking.

Methodological Issues

This study was carried out qualitatively where literature was the main source of the information. The qualitative approach through literature review was more revealing as it allows learning and challenging one's thinking. It was possible to learn that poor representation of women in STEM-related fields is not a problem for African countries

alone; it faces even the developed societies though at lower rates as compared to developing countries. The unit of analysis in this study was the women's underrepresentation in science and higher education. Qualitative studies in most cases do not permit generalization of the findings. In this study, however, women's underrepresentation seems to be a global problem though with varying degrees. Nevertheless, some of the problems that face Tanzania as a country when it comes to women's involved in the science field may not necessarily be generalized to other parts of the world, as these are context-specific in terms of culture and level of the economy. For example, the country faces overcrowded classrooms, a shortage of science teachers, lack of equipped laboratories and textbooks. These problems are rarely found in the developed world as opposed to African countries and Tanzania being inclusive. The study employed the historical design that in most cases, its source of information relies on what exists already being it in the soft or hard copy form.

Validity and Methods of Data Collection

When it comes to the validity and trustworthiness of the findings, triangulation of the data collection methods enhances the quality of the research findings (Patton, 2002; Bryman, 2004; Duffy, 2007). This study, however, relied solely on the documents as the source of information collected. Documents play a crucial role in historical research design, though it was necessary to sort out and select the most relevant sources of data or documents. It was also important to survey the related documents as much as possible to ensure the clarity of information from the authors' meaning. Data were collected from different times from 1995 to 2021. The use of documents as a method of data collection renders a contextual richness and, it grounds the investigation based on different contexts of the problem under study. Through the literature review, it was possible to identify the knowledge gap that exists in the STEM-related field and what the study could contribute to the learning society. It was also easy to gather more information from the empirical studies on STEM-related themes conducted in Tanzania and other African countries. It was also necessary to sort out the collected data for the coherence of ideas for easy understanding and for any person to follow if interested to read the article. Before concluding, it was necessary to verify the data from various sources for more accuracy of the informed findings.

Document Review

Various documents were reviewed including the empirical studies, international reports like that of UNESCO, United Nations (UN)'s declarations, editorial words, individual papers, Government policies, dissertations, academic journals, and other related materials. Documents gave the data that could have been collected using the interviews or questionnaires and they provided the contextual and some international data. Through documents, it was possible to collect data on factors responsible for women's under-representation in STEM courses in HLIs and why there is a need to involve women in science-related subjects. It was also possible to understand global and regional efforts towards girls' inclusion in the science field. Some empowerment statements towards girls' participation in STEM were useful for the data collected for this literature-based study.

Other literature gave the data on cultural beliefs and myths. Some books, journal articles, and materials were obtained through hand searching in the library. Some other journal articles were obtained through online searching on the internet. The Internet was useful for downloading various sources regarding gender-related articles from different countries. However, some literatures were old and some had no publication dates, but since

they had important information for the study were still employed as important sources of information for this study. Some data have been used for different purposes and intentions although they were important for gauging important information for the informed findings in this study. Moreover, some data were given according to individuals' interests and some were intended for sharing the knowledge on women representation in HLIs and not based on research. To mitigate these shortcomings, it was important to survey different sources of information as indicated earlier. As has been noted above, data were collected from both developed and developing countries.

Data Analysis and Ethical Considerations

Qualitative data were organized and subjected to content analysis after identification of the emerging themes as related to the rationales and factors behind the poor representation of women in the STEM field. This was done purposefully to meet the research objective. Data were analyzed using themes as formulated from the synthesis of the surveyed literature. It was important to screen the references from various studies and other document materials that were to inform the research findings. Plagiarism of the ideas from others was to a great extent avoided and well sought about it. Thus, it was necessary to make sure that authors and scholars of different journal papers and other materials were acknowledged so that to be appreciated for their contribution in the field of STEM and in the knowledge society.

Findings and Discussion

As has been stated earlier, the findings presented here have been collected through the literature survey. Thus, what is presented and discussed here is based on the secondary data that are presented by using themes as were organized and summarized to bring about the general understanding of the problem. While all the sources of information have been acknowledged, the themes employed in this study have been drawn as they were understood from both local and international literature.

Factors behind Women's Poor Participation in Science Subjects

From the literature, there seem to be multiple factors that are responsible for women's under-representation in STEM. Some of these factors include the stereotype concept of women themselves, cultural influence, psychological factors, and shortage of laboratories and teachers. Each of these factors is presented and discussed as follows:

Stereotype Concept of Women Themselves

The stereotype concept among individuals and community members that women cannot hold tools and machines appears to be among the factors that hinder women's participation in STEM (UNESCO, 2011). According to UNESCO, women's participation in STEM is mostly limited to soft engineering disciplines such as data processing, environmental issues, agriculture, chemical ceramics, and transportation. Most women do not involve themselves in physics, mechanical, civil engineering, natural resources, and energy engineering. According to Breda and Ly (2019), female candidates tend to perform slightly worse in written tests in science-related subjects such as in Mathematics and slightly better in Arts subjects such as in foreign languages. To Iwu and Azoro (2017), science-based subjects such as Chemistry tend to be given a masculine outlook by many educationists which discourages girls to opt for them and being attracted towards it. Yet, cultural-psychosocial stereotypes tend to portray a negative picture towards girls and

women exclusion from involving themselves in STEM courses. These courses, however, are at the center for any meaningful innovations of countries' economies. The mismatch between masculinity disciplines in STEM, the stereotypes, and its femininity based on gender role expectations among women are more likely to create barriers for girls and women's participation and their involvement in the STEM-related field at their every life stage.

Cultural Influence

Patriarchy and male dominance still continue to influence gender inequalities in many societies of the world have resulted in negative impacts on all levels of participation of girls in Science Education and Training [SET] (UNESCO, 2011). Girls and women tend to consider science to be a male domain. As observed by Dasgupta and Stout (2014), masculine gender role stereotypes orient boys to be more energetic, that is to say being able to acquire a mastery of skills and competencies, to explore the physical world around them, being critical and creative thinkers. To Dasgupta and Stout, boys are more likely to figure out how things are supposed to be worked out and at the same time try to gravitate towards those activities that involve problem-solving for their own lives and for financial gains. Marriage at an early age also affects women towards participation in STEM-related subjects.

As women step into their academic careers, at the same time they step into their new roles as wives and mothers (Wiley Online Library, 2016). It has been observed by Bipa (2010) that when a woman is about to gain experience as an active scientist, it overlaps with childbirth and child care. Most women drop out from science fields in different countries because of housework or duties, childbearing, and rearing, the most impeding factors for women to take part in science subjects (UNESCO, 2011), although this is mostly taking place in African countries. Nevertheless, as women or girls have socially ascribed responsibilities and roles such as motherhood (Olaitan, 2010), it limits them to access the labor market as well as their involvement in industrial activities to contribute to the family income and the nation at large (UNESCO, 2011).

Psychological Factors

Feeling that someone belongs in a certain academic and professional life is the psychological glue that influences someone's investment in the academic career (Disputa & Stout, 2014). Women themselves do not have confidence that they can handle science-related subjects. Even when they make options for their further studies, women tend to choose Arts subjects, unlike men who opt for the STEM field. Woman's underrepresentation in science subjects has not only affected the development of different countries, but also has affected the research development towards minimizing poverty in many countries (IDB, 2014; UNESCO, 2011). Few women tend to occupy the decision–making positions in academic and research institutions and their scientific role related to the research agenda is hampered (IDB, 2011). As a result, this adversely affects their self-esteem for them to think that they are capable and thus tend to undermine themselves to handle science subjects (UNESCO, 2011).

Shortage of Laboratories and Teachers

Due to the shortage of laboratories especially in Africa and Tanzania in particular teachers tend to teach theories rather than using practical (Bipa, 2010). It has been also reported by Simtowe (2021) that in Tanzania there is a serious shortage of laboratories in

Government secondary schools by more than 49 percent which affects teaching and learning in Chemistry, Biology, and Physics subjects. Other findings from Tanzania by Buhatwa (2014) indicated that secondary schools lacked practical lessons, science subject teachers, and a scarcity of laboratory facilities. Nyanda's (2011) study in Tanzania also found that the visited secondary schools lacked equipped laboratories to facilitate the teaching and learning of science subjects. Bipa's (2010) study on participation of women in Science Education in Tanzania found that examinations were given as an alternative to practical. Although this was a problem faced by both male and female students, it contributed to the problem where many female students did not qualify for university studies. Moreover, Hamilton et al. (2010) found in Tanzania that there was a wide discrepancy between knowledge, skills, and competencies among graduates in secondary schools and that of societal needs. This could have been contributed by the lack of practical learning for the students to be skilled-based and competent in their area of specializations. For them to apply the knowledge and skills in real-life situations for personal development and a nation in its totality they need laboratory practices. As observed by Babalola, Lambourne, and Swithenby (2019), practical work contributes towards students' better understanding and helps them to acquire professional and personal skills. Practice also gives the students motivation to continue learning during their studies at school and throughout their entire life.

As it has been noted above about a psychological problem of women not considering themselves as capable in the STEM field, lack of practicality may have contributed to their underrepresentation in higher levels of education. Teaching by using theories in science subjects without practical entertains rote learning, cramming rather than students' understanding and application of the knowledge. Other associated problems include the congested classrooms where a teacher finds him/herself unable to help students with individual learning problems including in science-related subjects. Semali and Mehta (2012), Bryat (2014), and Kinyota (2020) indicate their findings from Tanzania that most of the surveyed schools had overcrowded classrooms and they lacked textbooks including that of science subjects. They also found in their studies that many teachers were unqualified and that it resulted in poor teaching and learning with ending effects on poor performance in the STEM-related subjects.

Again, Mupa and Chinooneka (2015) found that primary schools lacked textbooks to facilitate teaching and learning of the science subjects. This problem resulted in low morale among teachers and since primary education is a base for further studies it affects the continuity of the science teachers for secondary education and for higher education. Thus, the educational sector suffers the consequences including deprivation of preparing the human capital and resources potential for socio-economic and technological development. The study by Hamilton, Mahera, Mateng'e, and Machumu (2010) in Tanzania found that there was a shortage of both human resources to produce knowledgeable and capable graduates for the development of a technologically competent labor force and materials that affected the quality of education. Projest's (2013) study in Tanzania found that lack of science teachers affected the schools as some of the science subjects were not taught at all and students were just left in the classrooms without anything to do during the science subject session. As the students were not engaged in learning, it resulted in indiscipline behaviors among them such as involving themselves in love affairs.

The shortage of teachers for science subjects in Tanzania has been alarming and it threatens the survival of both the educational and health sectors. Bipa's (2010) study in Tanzania for example, found that only one Physics teacher was responsible to teach from

Form I-IV. A recent survey by the team from the University of Dodoma (UDOM) in Dodoma region researching why Dodoma region performs poorly in the National Examinations confirmed the same problem as they found that only one Physics teacher was responsible to teach from Form I-IV in secondary schools (Dodoma Region report, 2018). It was so tedious and too involved for a single teacher to deal with all students. It should be noted that it was almost 10 years after Bipa's study in 2010; the same problem still existed in 2018. This suggests that there is something wrong with the training programs for teachers in the country and that if not well thought about it, higher education may continue to face the shortage of science students including poor representation of women within the field. The shortage of teachers harms the lower levels of education because universities will not have science students who are expected to teach at the secondary school level. In the long run, it impedes the country's human resources potential for development as noted earlier including leaving behind the untapped talents. The next section provides a framework that can help to curb the gap between males and females in higher education that in a long run may enhance an increased number of science teachers in the country's education system.

Conclusion and Implications

The study intended to survey the literature on the reasons as to why women have poor representation in science related fields in higher education in Tanzania and how to improve the situations so that women can participate in such field specialization. It appears that there is no single cause that acts as a hindrance towards girls and women from participating in the STEM fields. Various factors tend to be responsible for the problem ranging from socio-cultural (sociological) and psychological factors. From sociological factors, findings indicated that patriarchy system and male dominance have been responsible for gender inequality in STEM in Tanzania. Cultural myths and beliefs tend to affect women to participate in science field related courses as they believe that such a field is for men. Findings as well indicated that lack of academic background in science subjects while in secondary school level of education and early marriages of girls hinder their continuity to higher levels of education including the university education. These reasons discourage them to opt for science subjects even if female students joined the science stream at their secondary school education. Other factors that have been also reported to be serious in Tanzania include the shortage of teachers and laboratories to make students practice the theories gained in the classrooms. Psychological related problems include lack of confidence among female students as they consider themselves to be unable to handle science subjects as men do.

Based on these findings, it is argued in this study that there shall be no single bullet and solution to make sure that women take a stage in science related subjects (Dasgupta & Stout, 2014). Thus, there is a need to have collaborative efforts among policy makers, educationalists, and other educational stakeholders including parents and communities to work together if women are to take part in the STEM. At different levels of life stages, there is a need of having distinct social-cultural and psychological factors to create an environment that can make many girls and women involve themselves in science related subjects and inject in their minds a positive outlook towards STEM related fields. There is also a need to pre-orient the curriculum to encourage more women in science participation from lower levels. Teachers are to be sensitized for them to encourage girls to opt for science subjects and create a feel among girls that they are capable of learning STEM related subjects and they can even do better than men or boys do. This implies that the

Government needs to place more investment in laboratories in secondary schools so that students practice what they learn in the classrooms to build a sense of confidence upon them that they can do it. Increasing the number of science teachers is equally important if the Government wants to improve the female graduates in science and later on join the universities with the area of science specialization.

Educational institutions have to help the Ministry of Education in the identification of girls in Science Education and Technology (SET) fields by collaborating with the private sector in funding their studies through different scholarship programs. There is a need as well to have sensitization programs that target the girls, families and the society at its totality so that to build confidence and assertiveness among girls to take part in science subjects. The media have to set out some programs through which those girls who excel in science may have the opportunity to express themselves about their success to attract female students into science related subjects (UNESCO, 2011). As it has been noted, a more equitable gender balance is thought to be important for the enhancement of the recruitment of the most talented women irrespective of their gender status (Castilo *et al*., 2014). Thus, there is a need for more research on the causes of gender disparities in science fields and the creation of policy responses that address gender equality.

As the evidence indicates that shortage of trained professionals in the discipline of STEM is likely to weaken the innovation potential for the society, secondary schools and HLIs must devote more time in training the girls' minds to opt for science related courses unlike the current situation where girls mostly opt for Art courses. Indeed, if the African countries and Tanzania in particular want to improve their human capital (educationalists) and societies, then information on the women's positions and their contributions towards country' economy has to be well thought about (Guirado,1999). This includes the improvement of girls' access to scientific and technological related studies and careers in early ages especially at primary school levels. In addition, training programs on gender relations and equality among men and women and how they are implicated in their daily lives are equally important.

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