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Whose Names are in Science Textbooks? Justifying the Need for Critical Pedagogy in Tanzania Science Classrooms

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Abstract

Textbooks are the most important teaching and learning resources in education in most developing countries, including Tanzania. However, researchers in education have tended to ignore critical issues related to textbooks. For example, while Africa, as a continent, has contributed a lot to the development of science and technology, it is unfortunate that African scientists and their achievements do not feature in science textbooks used in African schools. This paper seeks to explore critical aspects in science textbooks that are often taken for granted, such as names of scientists cited in those textbooks. Additionally, the question of what are the stereotypes and the hidden messages that students in developing countries learn when science textbooks are full of white male Western scientists' names was considered pertinent for this study. We argue that such biased naming in science textbooks sends negative messages and stereotypes to students on what counts as legitimate science knowledge. We also argue that the messages, in turn, limit students' creativity and affect their identities as science knowledge producers and owners. The situation may be worse for non-white female students from developing countries. We recommend that teachers should use critical pedagogy in science classrooms so that issues related to the nature of science and the historical development of scientific knowledge are critically questioned, analysed and discussed. Given the limited time due to the pressure of national examinations, we also recommend teachers to use information and communication technologies (ICT) to facilitate critical pedagogy. Lastly, we call for the integration of indigenous scientific knowledge in science curriculum in Tanzania.

Keywords*: critical pedagogy, hidden curriculum, science textbooks, scientific knowledge, Tanzania*

1. Introduction

Africa's contributions to science and technology in various fields such as great astronomical discoveries among the Dogon of Mali have for centuries passed unacknowledged (Akpan, 2011). Therefore, it is not surprising that, globally, writers (Misiaszek, 2015; Ogawa, 1995; Snively & Corsiglia, 2000) have acknowledged the power of Western science knowledge, yet they have argued that indigenous science interprets how the world works in a given culture. Realizing that, Snively and Corsiglia (2000)

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pointed out that indigenous science fosters the discovery and development of aspects of science that are interwoven in day-to-day cultural endeavours. Additionally, Misiaszek (2015) and Ogawa (1995) have raised concerns that Western science has become a tool for disempowerment of local contexts. In that respect, there has been a struggle to restore indigenous forms of knowledge from dominant Western science discourses. Seen from this light, overreliance on textbooks based on Western knowledge may be seen as lacking these important aspects of indigenous science.

For the purpose of this paper, any use of the term 'indigenous science'—which is also referred to as 'ethnoscience'—means the study of systems of knowledge developed by a given culture to classify objects, activities and events of its given universe (Snively & Corsiglia, 2000); while, 'science' means universal ways of understanding the natural world as defined by Western standards. In the context of 'school science', we extend the definition of science as a body of knowledge and ways of thinking advocated in science textbooks.

In the context of Tanzania, textbooks are considered to be the most important teaching and learning resources that guide day-to-day teaching and learning activities. It is common to find secondary school students in Tanzania reciting science theories and principles such as: Newton's laws of motion, Archimedes' principle, Charles's laws, and Darwin's theory of evolution. For those familiar with the Tanzanian context, this is not surprising because they know that when national examinations are around the corner, students need to have these theories in their minds ready to write them in examinations. Remembering how definitions and principles appear exactly in textbooks is equally important as writing one's examination number. Students and teachers know that science knowledge is universal and everyone tries to observe that.

Since science knowledge is considered universal, critical pedagogy—which according to Hooks (2010: 1), should emphasize on "… an ongoing commitment to social justice, particularly to the struggle for racial equality"—is of less priority for curriculum planners and science teachers in Tanzania. As with other capitalist education models, science classrooms are dominated by teacher-centred methods (Zion et al., 2015), and the main goal becomes that of preparing students for vocations needed in the capitalist economy (Hooks, 2010; Marx & Engels, 2006). Science education follows what Apple (2004) described as the 'academic achievement model' where teachers and students learn to accept knowledge as unquestionable, "… as given, as neutral, so that comparisons can be made among social groups, schools and children" (ibid: 27). As such, in this context knowledge transmission is more important than knowledge production.

2. Study Purpose

The perceived universality of science raises innumerable questions as many critical theorists such as Paulo Freire (2005) and Michael Apple (2004) have asserted. Such questions include: Who decides what should be taught as science content? Whose knowledge counts as legitimate? Who knows the examples that teachers give to students? And finally, who knows the impact of those examples given by teachers to students as they internalize them? In connection to these questions, the major purpose of this paper is to explore critical aspects in science textbooks. The focus is mainly on the

aspects that are often taken for granted, such as names of scientists cited in those textbooks. In addition to that, the question of what are the hidden messages that students in developing countries learn when science textbooks are full of names of white, male and Western scientists was also considered pertinent in this study. For that matter, the major claim of the paper is to uncover the implications of such names of scientists cited in textbooks to students' attitudes towards science subjects and towards students' self-identity as science knowledge producers and owners.

3. Secondary Education in Tanzania: Science Curriculum, Syllabi and Textbooks

Since in this topic the main focus is science textbooks in secondary schools, a clear understanding of the Tanzanian context in terms of the system of education is pertinent. The education system in Tanzania follows the 2-7-4-2-3^{+} arrangement, where the numbers stand for years of nursery, primary, ordinary level (O-Level) secondary, advanced level (A-Level) and university education, respectively. According to the Ministry of Education and Vocational Training (MoEVT) (2014), the government launched a new education policy in 2014 which stipulated that years of education have to be reduced from the former 2-7-4-2-3^{+} arrangement to 1-6-4-2-3^{+}. With the exception of the nursery level, students must pass national examinations to qualify to join the next level. These examinations are centrally prepared by the National Examination Council of Tanzania (NECTA) under the Ministry responsible for education. Having a clear understanding of the examination system in Tanzania is significant as it influences the implementation of critical pedagogy in science classrooms. Thus, we will discuss its details later in the next sections.

Curriculum development in the country is centralized and the Tanzania Institute of Education (TIE), under the Ministry responsible for education, is in charge of the development and distribution of curriculum materials such as syllabi and textbooks, which are the same countrywide. Topics in textbooks are usually arranged either from simple to complex, or on how one topic influences the next topic. Usually teachers and students follow the sequence as the topics appear in textbooks and/or in the syllabi.

A science curriculum is organized into three subjects (Physics, Chemistry and Biology), with each subject having its own syllabi, textbooks and usually separate teachers. The topics in science textbooks are organized with topics summarized in terms of concepts, theories, and principles that students must understand, although in most cases they just memorize the textbook knowledge (Vavrus & Bartlett, 2012). Also, textbooks have exercises to enable students to revise and practice what they have learned. The pressure to cover all the topics is very high, and as such teachers have no time to discuss with their students in detail the contents of each topic, including the biographies of scientists mentioned in textbooks in science classrooms (Paul & Tilya, 2014). However, even in the absence of such discussions, it is still easy to recognize that these are names of male, white and western scientists. Firstly, these names do not look and/or sound like Tanzanian traditional names. Secondly, the arrangement of vowels and consonants in these names appears to contradict with those of most Tanzanian traditional names. Table 1 indicates the scientists' names, sex, race/nationality, ideas and the grade level in which these scientists' ideas appear in science textbooks used in Tanzania secondary schools.

Table 1: Common Names in Science Textbooks in Tanzania

Scientists' name	Sex	Race/ Nationality	Main idea	Grade level
Michael Faraday	Male	White-United Kingdom	Electrolysis	Physics, form 3
Robert Bunsen	Male	White-Germany	Heat sources and flames	Chemistry, form 1
Gregor Mendel	Male	White-Czech Republic	Genetics	Biology, form 4
Isaac Newton	Male	White-United Kingdom	Laws of motion and astronomy	Physics, forms 2 and 3
Charles Robert Darwin	Male	White-United Kingdom	Evolution and natural selection	Biology, form 4
Henry Louis Le Chatelier	Male	White-France	Chemical equilibrium	Chemistry, form 3
Jean-Baptiste Lamarck	Male	White-France	Evolution and natural laws	Biology, form 4
Archimedes of Syracuse	Male	White-Greece	Archimedes' principle	Physics, form 1
Friedrich Gustav Jakob Henle	Male	White-Germany	Anatomy and loop of Henle	Biology, form 3
Robert Hooke	Male	White-United Kingdom	Theory of elasticity	Physics, form 2
Democritus	Male	White-Greece	Atomic theory	Chemistry, forms 1 and 2
John Frederic Daniell	Male	White-United Kingdom	Electrochemistry and Daniell Cell	Physics, form 3
Amedeo Avogadro	Male	White-Italy	Molecular theory and Avogadro's constant	Chemistry, form 3
Georg Ohm	Male	White-Germany	Electrochemistry or Ohm's law	Physics, form 3
Georges Leclanche	Male	White-French	Electrical Cells	Physics, form 3
Robert William Boyle	Male	White-Ireland	Boyle's law or Gas law	Physics, form 2 and Chemistry, form 3
Wilebrord Snellius	Male	White-Netherlands	Astronomy and laws of refraction	Physics, form 3
Nicolaus Copernicus	Male	White-Poland	Astronomy and Copernicus law	Physics, form 3
James Prescott Joule	Male	White-United Kingdom	Thermodynamics	Physics, form 3

Sources: SCSU & MoEVT (2012); South Carolina & MoE (2008); TIE (1994)

The opinion that science is objective is ingrained in most teachers and students to the extent that questioning science knowledge is equated to committing a crime. According to critical realists and theorists, knowledge is situated; and every knowledge sources and assertions should be open to critique in a way that embraces multiple perspectives (Apple, 2004; Bryce, 2011; Zion et al., 2015). It should not be a crime for teachers and students to discuss the historical development of science knowledge in science classrooms. Related to the organization of official knowledge, Sprague (2010: 86) has noted that:

> …the bodies of those dominating the production of knowledge have for the most part been in specific social locations in systems of race (white), class (privileged), gender (male), and nation (Western), and yet there is no consideration of how their observations might have been shaped by their social position.

Understanding that scientists' social positions influence the way they view and generate knowledge is very important in physical sciences. In other words, such understanding helps teachers and students to treat scientific knowledge with some level of suspicion and contextualization. This is to say, through such an understanding, teachers and students are made aware that any scientific knowledge is influenced by the social, cultural and political contexts under which it was created (DeJong-Lambert, 2004).

4. Science Textbooks and the Power of Hidden Curriculum

Alsubaie (2015: 125) has defined hidden curriculum as "… the unspoken or implicit values, behaviours, procedures, and norms that exist in the educational setting." Hidden curriculum exists in any educational setting in many forms ranging from what teachers do and say consciously or unconsciously, various forms of texts that students interact with, and student-student interactions. Just as is the case with formal curriculum, hidden curriculum is a very powerful learning tool for students. For instance, in its various forms hidden curriculum works as a socializing agent where students are taught to accept certain roles and identities in society (Apple, 2004; Balboni et al., 2015; Condon et al., 2014; Mason, 2015). In a traditional teaching context where the teacher talks and students listen, the message is very clear that the teacher is the source of knowledge, while students are the recipients of that knowledge (Freire, 2005; Hooks, 2010). Freire (2005) referred to this as the banking concept of education in which students, among other things, are taught to see the teacher as the source of knowledge—an authority not to be questioned. Using the banking metaphor, Freire equates this scenario with the process of depositing (similar to the act of teaching), depositor (teacher) and depositories (student).

Hidden curriculum has both negative and positive impacts, and teachers need to be aware of its existence and the impacts it may pose to students' learning (Alsubaie, 2015). Unfortunately, the existence of hidden curriculum and its impacts are ignored in educational discourse in Tanzania. This is partly due to teachers being unaware of its forms and impacts mostly because the nature of the formal curriculum and national examinations put more pressures on teachers to complete the contents of the curriculum.

As noted earlier, usually students in science classrooms learn the definitions, theories and principles of male, white and Western scientists. Here, we are not suggesting that it is wrong to read and learn from male, white and Western scientists and philosophers: the purpose is to uncover the hidden messages in such readings. For example, students may be inspired by these scientists and thus increase their self-efficacy of knowledge creation. On the other hand, female students may pick a negative message that it is only males who are born to be scientists. Non-white students may also pick the message that only whites are born to be scientists. The same may be the case with students from developing countries where no scientists from their regions are written in science textbooks. All these aforementioned examples constitute some hidden messages that can form what we refer to in this paper as hidden curriculum.

Hidden curriculum makes the school a very complex learning environment since as a school sets the goals and objectives to be achieved by students through a formal

curriculum, at the same time a hidden curriculum is operating in a way that may positively and/or negatively influence the achievement of such goals and objectives. Sometimes hidden curriculum sets its own goals and objectives for the same students. For that matter, as Alsubaie (2015) has noted, teachers should be aware of the powers of hidden curriculum and device strategies to deal with it.

4.1 Unpacking Hidden Curriculum: The Need for Critical Pedagogy

As mentioned earlier, upon deeper investigation of the nature of the contents of science textbooks, science classrooms in Tanzania call for the use of critical pedagogy. Critical theorists have stressed the idea that knowledge is being reproduced through other means other than the overt or intended ones (Alsubaie, 2015; Apple, 2004; Apple & Au, 2009; Marx & Engels, 2006). Many factors—including the pressure to cover the syllabus and prepare for national examinations—have resulted into the tendency of ignoring the hidden aspects of learning in many countries, such as Tanzania, which are examination-oriented. Critical theorists view this as a big mistake since it results into the reproduction and maintenance of social classes. For example, when discussing the role of critical theorists, Crotty (1998:144) noted that "… in discourse the beliefs, norms and values that are taken for granted in everyday interaction are expressly thematised and subjected to critique." Based on this understanding, the names of scientists used in textbooks may constitute 'the taken for granted' message that may have impacts on students' attitudes towards science subjects and the creation of science knowledge. Using the metaphor of an iceberg, Kellner and Share (2007: 63) warned of the impacts of 'taken for granted' meanings in media literacy succinctly by underscoring that:

> The critical component of media literacy must transform literacy education into an exploration of the role of language and communication to define relationships of power and domination because below the surface of that iceberg lies deeply embedded ideological notions of white supremacy, capitalist patriarchy, classism, homophobia and other oppressive myths.

Educators, therefore, should consider the hidden aspects in text and talk as they may have impacts to students and themselves. In this paper we use a critical theory perspective to justify the need for critical pedagogy in science classrooms in Tanzania's secondary schools.

5. Critical Pedagogy: A Theoretical Framework

The concept of critical theory can be traced back to the works of Karl Marx, the Frankfurt school of thought, and later Paulo Freire. The works of the Frankfurt school of thought helped to popularize the theory, which seeks to challenge all forms of power domination with the goal of creating a critical and just society (Apple, 2004; Apple & Au, 2009; Crotty, 1998; Scherr, 2005). Although critical pedagogy borrows from the works of Karl Marx and the Frankfurt school of thought, it is basically less of a Western philosophy but rather a Brazilian movement that was established by Paulo Freire. The movement was meant to resist the colonial hegemony, with the focus of creating a just society. Critical pedagogy was applied to educate people in Brazil, where 300 sugarcane adult workers successfully became literate (Gadotti & Torres, 2009). In their entire learning process, the theory required these adult learners to learn by making dialogue with their educators.

At the core of critical pedagogy is the understanding of the connections between education and the relations of dominations, as well as how societies struggle against such dominations (Apple et al., 2009; Freire, 2005). For example, Paulo Freire rejected the concept of banking education where students are considered as having nothing to contribute in the learning process. Spear and Costa (2018) asserted that such methods of teaching contribute to the maintenance of existing power structures. Furthermore, Apple et al. (2009) noted that before the phrase 'critical pedagogy' was coined by activists such as Paulo Freire in Latin America, other forms of critical education had been practiced in the U.S.A and elsewhere. According to Apple et al. (2009), such forms of education challenged existing power structures and other forms of inequality in education such as those based on race, gender and class. Many critical analysts had called for the creation of platforms that would ensure that "… people in marginalized positions have the opportunity to collectively struggle against oppression, to voice their concern, and create their own representations" (Kellner & Share, 2007:61). This is only possible if people have reached the level of self-conscientization.

Such aforementioned assertion may not work for Tanzania students because studies have indicated that most students in science classrooms in Tanzania require reciting the content in textbooks from topic to topic (Vavrus & Bartlett, 2012). We view this kind of learning as a typical reflection of the banking concept of education. Although there is an increased emphasis on the use of more learner-centred methods in science classrooms in Tanzania (MoEC, 2005), such methods do not involve the discussion of issues of knowledge and power.

It may easily be tempting to confuse critical pedagogy with other learner-centred methods. While both emphasize the active involvement of learners in the process of learning, the former involves a serious commitment to issues of knowledge and power, as well as social justice. To highlight on this, Apple and Au (2009: 997) noted that:

> Freire's critical pedagogy revolves around the central idea of 'praxis', the unification of critical reflection and critical action. It seeks to be a pedagogy that enables students and teachers to be 'subjects of their own history'. … who can look at reality, critically reflect upon that reality, and take transformative action to change that reality, thereby deepening their consciousness and working toward a more just world. Making use of the teaching methods of problem posing and dialogue, Freire's critical pedagogy intends for all relationships of hierarchical power to be challenged, including that of the student–teacher relationship. In this way, Freire's critical pedagogy invites students and teachers to become change agents both in their classrooms and in the world around them.

Other learner-centred methods can claim the role of students' contribution in the classrooms but they are silent on issues of power and knowledge, and social justice in general. The use of critical pedagogy in science classrooms in Tanzania can be justified as Apple (2004) has argued that knowledge (in textbooks) involves a 'selective tradition', where knowledge and meanings from the ruling class are selected and emphasized for a purpose; while others are neglected, excluded, diluted or reinterpreted. The main purpose becomes that of reproducing and maintaining existing power structures in the society (Alexander & Jarman, 2015). Critical pedagogy helps science teachers and students to discuss issues of

knowledge and power: specifically, why and how they came to accept the knowledge they learn today in science textbooks. Alexander and Jarman (2015) stressed the need for an emancipatory approach to education. The approach empowers students to unveil and decode the ideological dimensions of texts, institutions, social practices and cultural forms such as television and film, so as to reveal their selective interests. The power of textbook knowledge needs not to be underestimated because its impacts can be long living ones after students have memorized it. Smith (1987: 3) has argued that "… we are ruled by forms of organization vested in and mediated by texts and documents." Smith (ibid.) has also revealed how schools teach students to recognize and approve ideologically sanctioned forms of relations, including recognizing who are the legitimate speakers and writers, and those who are not. This calls for the need to uncover such hidden curriculum in school practices. Uncovering such hidden curriculum in school practices will go hand in hand with the current emphasis on the need for critical education in Tanzania.

The question put forward by Apple et al. (2009:12) on whether critical pedagogy can be put into practice remains a challenge in Tanzanian science classrooms. Apart from common challenges, such as pressure to prepare students for national examination in public education (Kellner & Share, 2007), another challenge of using critical pedagogy in science classrooms comes from the persistent beliefs held by teachers, students and the scientific community in general regarding the objective nature of science. Also, the implementation of critical pedagogy is limited by the large number of students in most of Tanzania's secondary schools. There is a need to prepare and hire more science teachers who could help reduce the large number of students by splitting classrooms into small and manageable ones.

School science as opposed to social sciences is taught and seen as objective, universal and empirical. Science is perceived as being shielded from any outside influences, either personal or political (Apple, 2004). As such, the power dimensions that are involved in science knowledge production are neglected. Related to this view of scientific knowledge, and specific to this paper, is the abundance of white, male and Western names of scientists in science textbooks. While this phenomenon is taken for granted, it has some impacts on students' attitude towards science and the creation of scientific knowledge. To deal with this phenomenon, Apple (2004) argued that students' perceptions that it is 'them' who are the holders of expertise knowledge must be radically altered.

Closely related to the challenges of putting critical pedagogy into practice, it is also suggested that students in science classrooms in Tanzania need to discuss the historical development of scientific discovery, thereby enabling them to understand science subjects in their historical contexts, and so become conscious of why, how and what they learn in textbooks came to be the way it is. However, this will happen only if students are given a chance to voice their opinions, and teachers are ready to seek and value students' point of view. In other words, schools and teachers should constantly work towards rejecting the banking concept of education. Also, issues of knowledge and power with regard to scientific knowledge and discovery need to be discussed in science classrooms so that students can shape their identities as science knowledge creators, and not only as consumers. In support of this, Kellner and Share (2007: 66) have highlighted:

> Consistent with critical pedagogy, the students move from being objects of other people's research and media representations to becoming subjects empowered to tell their own stories and collectively challenge dominant oppressive myths.

Given the overemphasizing of content coverage and national examination preparations in Tanzania, the time to put critical pedagogy in science classrooms into practice seems limited. From this challenge, we now discuss the opportunities offered by ICTs.

6. Information and Communication Technologies (ICTs) and Critical Pedagogy

The rapid development of ICTs offers both educational opportunities and challenges. While ICTs have facilitated teachers' and students' access to information, access to learning beyond the four corners of classrooms and access to rapid and interactive communication, they also present challenges related to their use in the classroom (Kellner & Share, 2007; Lacina, 2007). All day long access of information is an opportunity that teachers and students could fully utilize in searching and learning about the historical development of science knowledge and biographies of scientists whom students learn in science textbooks. The access also gives teachers and students an opportunity to question issues related to knowledge and power. Regrettably, when asked why teachers prefer the banking concept of education, most of the time they blame the education system for overemphasizing content coverage and pressures related to national examination preparations (Paul & Tilya, 2014). Given the limited time and the need to cover the syllabus content, ICTs can offer opportunities for teachers and students to use out-of-class hours to learn many other things such as questioning why many science textbooks have only documented the names of male white scientists. However, this has to start with the conscientization of teachers that such hidden agendas are worth exploring.

Regarding issues of knowledge and power, ICTs offer both costs and opportunities. While interactive ICTs are used as means of facilitating global capitalism, they also provide space for different groups in society to voice against various forms of oppression (Gadotti & Torres, 2009; Kellner & Share, 2007). Seen from this light, teachers and students in science classrooms can use interactive social media technologies such as WhatsApp, Twitter, Facebook and WeChat to give out their voices and carry on live discussion of issues related to social justice such as rejection of hegemonic structures in textbooks and teacher-students relationships. Teachers can also use such technologies to plan students' discussions on the historical development of Western scientific knowledge, as well as indigenous science knowledge and discoveries. The challenge remains that students in Tanzania are not allowed to use mobile phones, and many schools, especially in rural areas, are not equipped with computers and other learning technologies. This remains to be a policy issue worth being intervened. The government needs to invest more in education, and this has to become the first priority to ensure that schools are connected to computer systems and the Internet. Such efforts will be directly connecting Tanzania secondary schools to the globalized world.

7. Science Education in a Globalized World

Competition in the global economy plays at the advantage of those who invent and control technological innovation. Science and technology is an important dimension of

globalization, and differences in development between countries somehow correspond to their differences in the advancement of science and technology (Stromquist, 2002; Torres, 2002). This being the case, science education in Tanzania should take a turn from learning science as a body of knowledge (learning what others have discovered) to include aspects of science as a way of knowing (attitudes of discovering own science knowledge) to enable the country compete in the global economy. In other words, the development of inquisitive minds and creativity should become the main goal of science education. The discussion of the historical development of science knowledge can improve students' attitudes toward science knowledge creation as opposed to believing that science knowledge does not belong to them as it is taught both through the overt and hidden curriculum.

One of the impacts of globalization is the neglect of local cultures—the indigenous ways of learning science. This is because globalization involves convergence where all societies are subjected to 'the same forces' (Arnove, 1980: 49) with increasing cultural hybridization (Torres, 2002). Global convergence will continue to strengthen peoples' attitude of science as universal; and science education will be more integrated to global capitalist agendas.

Therefore, as the definition of development changes in a globalized world, so do the goals of education. Learning the same science content is seen as the best way to prepare citizens who will compete in the global economy. The fear that cultural norms and infrastructures—part of which is indigenous scientific practices and knowledge production—are deteriorating as globalization rises to its peaks becomes justified. For that matter, globalization will continue to challenge the inclusion of indigenous knowledge in school curricula. Therefore, any attempt of reforming schools, such as the use of critical pedagogy, has to consider the dimension of globalization.

Since the focus is on the names of the scientists used in science textbooks, and studies have indicated that females have always been underrepresented (Legewie & DiPrete, 2014; Settles et al., 2016; Stets et al., 2017; Wang & Degol, 2013), the discussion of gender in science education deserves a special attention. There is no doubt that females' participation and performance in science, technology, engineering, and mathematics (STEM) has been a central topic in science education (Francis, 2000). As stated earlier, given that females continue to be underrepresented in STEM (Legewie & DiPrete, 2014; Settles et al., 2016; Stets et al., 2017; Wang & Degol, 2013), it is likely that stereotyping has led to the continued limited use of science textbooks written by females. This is consistent with the long history of gender stereotypes that have resulted into the emergence and popularization of movements such as feminism. Just like other forms of oppression, gender stereotypes have been internalized by people to the point that some have been accepted as norms (Clegg, 2008; Freire, 2005; Hale, 2012). Here, we concur with radical feminists when they emphasized that:

> …the oppression of women is the oldest, most profound and most widespread oppression of all. It is the view of some radical feminists that the oppression of women causes more suffering than any other form of oppression. Some propose the oppression of women as the model for understanding any other form of oppression (Crotty, 1998: 164).

Smith (1987: 22) has documented 'the brutal history of women's silencing' where she gives cases of females and males co-authored works being only considered as written by males only. In the US females were purposely and systematically excluded from the profession of medicine by keeping their admission in very small numbers. According to Smith (1987) other female writers were killed because of identifying themselves as knowledgeable. Also, Smith gave an example of Joan Boughton and her daughter Lady Young who were burned during the 15th century because of giving their own interpretation of the Bible.

STEM education, as a field of study, is not immune to gender stereotypes. Gender stereotypes are evident from the macro level (list of worlds' famous scientists) to the micro level (teaching and learning in science classrooms). According to Francis (2000), school subjects, and consequently careers, have been gendered. Controlling careers such as engineering and medicine are associated with the male gender, while caring careers such as teaching and nursing are associated with the female gender (Towse et al., 2002).

Given the complicated history of gender stereotypes, the continued unfair representations of females in the scientific community continue to pose threats on females' attitudes towards STEM subjects. As discussed earlier, the absence of female scientists in science textbooks may continue to spread gender stereotypes unless teachers and students openly discuss issues of knowledge and power in science classrooms. Educators at this point may not be able to reverse this trend, but the discussion of the historical development of scientific knowledge can help shape females' identities as science knowledge producers and owners just like their male counterparts.

8. Conclusion

The view that science is universal and objective contributes to teachers' tendencies to ignore issues of knowledge and power in science classrooms and textbooks. As a result, science teachers, especially in developing countries, have overemphasized the teaching of school science as a body of knowledge (scientific theories, principles and laws discovered by others), than teaching science as a way of knowing (Snively & Corsiglia, 2000). While issues of knowledge and power are not discussed in science classrooms, research has shown that they may have impacts on students' attitudes towards science, and on the development of indigenous forms of scientific knowledge. The use of critical pedagogy in science classrooms can offer an opportunity to teachers and students in Tanzania to uncover the hidden messages in science textbooks in a way that will empower science students. The empowerment we are referring to here is that of teachers enabling students to change from being passive and dependent, to being active citizens (Pacho, 2013) who have power to discuss and critique the content of science textbooks. In other words, students should be given chances to construct their own knowledge; but they cannot do that if textbooks discourses discourage them by indicating that it is only male, white and Western scientists who can discover knowledge. Females, as history has shown, are more affected by such kinds of discourses.

The pressure to cover the national curriculum and preparations for national examinations are expected to continue to challenge the adoption of critical pedagogy in science classrooms unless immediate measures are taken. Such measures include emphasizing

competence-based learning in its real sense. Preaching competence-based learning while at the same time being too much focused on examinations only lead to contradictions. However, at a time when national examinations are still given a top priority, ICT can help fill the niche if properly used by teachers and students. As stated earlier, the first priority should be on the government investing in education to help schools be connected with computer systems and internet networks. This will provide a room for teachers and students to discuss and question a number of hidden agendas that are not discussed in the normal classroom hours due to time limit. Finally, issues of knowledge and power in science should be emphasized in teacher training programs.

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