THE EFFECT OF CONTINUING PROFESSIONAL EDUCATION ON SCIENCE TEACHERS' COMPETENCE AT SECONDARY SCHOOLS IN TANZANIA

by

SUSANA J. NKURLU

(Under the Direction of Laura L. Bierema)

ABSTRACT

In Tanzania, the number of students dropping science subjects has risen greatly, and their interest in science is very low. As a result, students perceive science subjects to be more difficult, unappealing, and irrelevant. One of the key factors in this decline is an unsuitable and outdated approach to the teaching of science in schools that ultimately inhibits students' learning.

One of the solutions to this dilemma is to allow teachers to participate in professional development programs. Research has shown that participating in professional development activities is one way teachers develop the expertise necessary to enact inquiry-based practices in their classrooms. Thus, this study sought to (a) understand how the professional development learning experiences of Tanzanian secondary school science teachers influenced their instructional practices and (b) examine the approaches that science teachers utilized in the classroom, specifically the inquiry-based approach.

This study was conducted with 13 participants who are secondary school science teachers, and it used semi-structured interviews, observations and document analysis. The three research questions guiding the study were: (1) What kinds of professional development opportunities do science teachers receive? (2) What methods do Tanzanian secondary school teachers use to teach science to their students? (3) How do science teachers come to understand and make sense of what an inquiry-based approach means in teaching science?

The findings resulted in four main conclusions for the study: (1) the professional development for teachers was limited, inconsistent, and uneven and did not meet the modern standards of science education; (2) quality teaching was hindered by government policies that limited access to resources and infrastructure; (3) the Tanzanian science curriculum does not incorporate the inquiry-based approach; and (4) the encumbrance of teaching science to meet the requirement of the curriculum significantly affected the quality of the instruction.

INDEX WORDS: Tanzania, Adult Education, Qualitative Case Study, Professional Development, Secondary Schools, Continuing Education, Inquiry-Based Approach, Science Teachers

THE EFFECT OF CONTINUING PROFESSIONAL EDUCATION ON SCIENCE TEACHERS’ COMPETENCE AT SECONDARY SCHOOLS IN TANZANIA

by

SUSANA J. NKURLU

B.S., Grand Valley State University, 2004

M.S., Grand Valley State University, 2006

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2017

THE EFFECT OF CONTINUING PROFESSIONAL EDUCATION ON SCIENCE

TEACHERS' COMPETENCE AT SECONDARY SCHOOLS IN TANZANIA

by

SUSANA J. NKURLU

Major Professor: Laura L. Bierema

Committee: Juanita Jonson-Bailey
Lioba Moshi
David Jackson

Electronic Version Approved:

Suzanne Barbour
Dean of the Graduate School
The University of Georgia
May 2017

DEDICATION

This dissertation is dedicated to my loving parents: to my father, the late Mr. Jackson Nkurlu and to my mother, Mrs. Jackson Nkurlu, who have helped me become who I am today. Thank you for raising me in a Christian home, and for teaching me right from wrong. I'm still learning and growing; however, the morals and beliefs that you instilled in me have certainly made a difference in who I am and the person I am becoming. I am grateful for your unconditional love and for always believing in me. Truly, you laid down a solid foundation for my education and hence for my life, and for this, I will forever be grateful.

ACKNOWLEDGEMENT

Numerous people have helped me reach this point in my life, and I am indebted to all of you. First, I would like to begin by expressing my deepest appreciation to my advisor Dr. Laura Bierema for all your tireless work as my major professor. You have been the most wonderful advisor anyone could ask for. You were very supportive, and every time I had an opportunity to meet with you, I became more confident about my ability to complete my research – thank you for always believing in me. Thank you for your leadership role in guiding and directing the dissertation process; your suggestions, encouragement, assistance, advice, and guidance have been invaluable, not only in this dissertation but throughout every step of my graduate career. Truly, your pursuit of excellence has been a source of motivation and strength for my work. Dr. Bierema, you are the best advisor ever!

I am also very fortunate to have Dr. Lioba Moshi, Dr. Juanita Johnson-Bailey, and Dr. David Jackson as my committee members. I would like to thank Dr. Lioba Moshi for wise counsel and direction on many aspects of my dissertation, particularly on issues concerning teacher education in Tanzania. You will forever be my “Mwalimu” (Teacher). Thank you for your mentorship throughout my PhD journey and teaching career at UGA; you have guided me on the right path. I will always be thankful to you. I wish to thank Dr. Juanita Johnson-Bailey for her profound observation and feedback, specifically in the areas of conceptual and methodological issues in qualitative research. Thank you for always being available when I needed you the most. When I thought I could not do it, you told me that I could. For that, I can never repay you. I would like to thank Dr. David Jackson for your meticulous attention to detail

and for providing me with valuable insights into the efforts of academic research. How can I say thanks in a way that will actually express my genuine appreciation? You are certainly an excellent provider of feedback and thus, I am so blessed that you were on my dissertation committee. Truly, I thank all of you for the insightful ideas, recommendations, guidance, and support. All of you are remarkable professors.

A special acknowledgement goes to Dr. Talmadge Guy, who has always been on my side even before I began this journey. Thank you so much for standing by me especially in trying times. You advocated for me and encouraged me to be strong. I love, respect, and adore you for your endless well of support, warmth and genuine kindness.

Very special thanks go out to my parents and siblings, especially my parents, the late Mr. J. Nkurlu and Mrs. J. Nkurlu. My sisters, Sungi, and Welu, and my brothers, Gwila, Melkezedek, and Jacob for giving me a great deal of encouragement, support, and assuring me that I could absolutely persevere. All of you have shown me unconditional love and support over the last several years. I must recognize “Dada” Welu for checking up on me dailyday and night and sending me Bible verses. Thank you for your love. Melkezedek, your assistance is greatly appreciated and will never be forgotten. I would like to make very special mention of my dad who is no longer with us. I miss you dearly, dad. I wish that you could be here to share and celebrate this wonderful moment with us. I know you would have been very proud of your youngest daughter.

Of course, I could not have done this without the support of the family members: my uncles, aunties, cousins, nephews, and nieces. Thank you so much for your continual support and prayers. Some of those who deserve special recognition are Mr. and Mrs. Howard Shila (Aunt Martha, in all of my three defenses, you were always the first one to text and ask, “Shangazi,

How did it go?” You always made my heart smile. Patricia and Ben Nshalla, thank you so much for all your help during my data collection process in Arusha. Indeed, I could not have made it without your support. Maseke Chacha, thank you for following up with the research permits for me. Musa Shila, thank you for always inquiring about my progress, and for encouraging me beyond words. Leah Nkurlu, thank you so much for being my mentor.

Very special thanks go to all my friends who have supported me from the beginning of my PhD voyage to the critical months of my dissertations. Your patience, love and encouragement made the long hours spent in the library a little easier to bear. I must acknowledge these individuals: Josina Kileo, Rose Nawade, Ketthsy Capre, Maxine Gray, Garrett Fox, Zaituni Mnubi, Geoffrey Shilla, and Rachel Kibaya. Thank you for always being there for me when I needed you the most. Indeed, we have come a long way, and your sacrifices have not gone unnoticed.

My heartfelt gratitude is extended towards many of my fellow graduate students inside and outside of my program for assisting, encouraging, and persuading me to keep my eyes on the light at the end of the tunnel. These individuals deserve special recognition: Mohammed Alasmrai, Gabriel Ayoola, Beatrice Lele, Joy Bradley, Hyeri Park, Kadeghe Fue, Jeong-Ha Yim, and Katie Davis. All of you continue to be examples of the kind of loyalty I desire in my own life. Thank you for showing me the meaning of true friendship.

I am also grateful to my colleagues who have supported and encouraged me throughout the program. Specifically, I would like to thank the UGA African language teachers: Dr. Moshi, Dr. Ojo, Dr. Traore, Dr. Maganda, Mr. Gabriel Ayoola, and Ms. Zarina. I thank God for the gift of teaching and the ability to share and impart this skill with others. I would like to thank the faculty in the Department of Comparative Literature for the financial support during the entire period of my studies. I appreciate so much the assistantship opportunity you provided me until the completion of the program. Also, I would like to acknowledge our office manager, Ms. Jill Talmadge – thank you for kindly providing me with your warmhearted encouragements every time we bumped into each other. You uplifted me in one way or another.

To all my research participants, thank you so much for allowing me into your classrooms and lives. If all of you had not allowed me the privilege of access to your classrooms and provided me with such insightful accounts into your worlds, I undoubtedly would not have been able to complete this dissertation. I recognize your generous support of my work and interests, including the time you spared to converse with me, your willingness to permit me to record our interactions, showing me great respect and hospitality while observing your classrooms, and being willing to provide your teaching documents. Importantly, I would like to thank all those individuals, particularly, three headmasters and a headmistress, for connecting me with participants in the first place. This made access to my research sites much easier and smooth. All of your efforts contributed greatly to the completion of my research. All of you are wonderful teachers, and I am very grateful to have been a small fraction of your lives.

Many thanks to UGA writing center associates, particularly, Stephanie Short and Laura Clark. You have been very supportive from the beginning of this process and I truly appreciate your generous help. The act of proofreading my paper has profoundly improved the composition of this dissertation.

Very exceptional thanks are extended to my church family “The Redeemed Christian Church of God – Amazing Grace Parish” for always keeping me in your prayers and reminding me that God is in control and that my help comes from the Lord, the Maker of heaven and earth. Those deserving a special mention are: My incredible Mummy who is also my Pastor, Dr.

Moradeke Aderibigbe and my ever wonderful Daddy serving as an Assistant Pastor, Dr. Simon Aderibigbe. I would like to say a huge thank you to both of you for many years of support, encouragement, and assistance. You have taken the role of being my parents during my stay here in Athens and I must admit that I could not have made it this far without you, your compassion, and your love. Additionally, I would like to thank all my church members, especially Ms. Olutola Akindipe, Ms. Grace Ayoola and Mr. Gabriel Ayoola, and Ms. Bisi Adeyemi-Bajo.

My strongest appreciation and adoration are expressed to my Lord and Savior Jesus Christ. Unquestionably, without your grace none of this work would have been possible. Indeed, if it were not for you, my Lord, I would not have even attempted this journey. I humbly acknowledge with thanks the Almighty God for His grace, strength, and love to accomplish this research. I thank Him for sustaining me in my studies and I must say that I have made it this far because of His assurance that I should not be afraid, for He is with me. I should not be discouraged, for He is my God. He will strengthen me and help me. He will hold me up with His "victorious right hand" (Isaiah 41:10). My Lord, I give you all the glory, honor, and all the praise for You alone deserve it.

I have probably forgotten other individuals who also made an impact in my life and contributed in the completion of my research; kindly forgive me.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

There has been a decline in the number of students interested in studying science all over the world (Trna, Trnova, & Sibor, 2012). Studies have revealed that one of the key factors in the decline is an inappropriate and outdated approach to the teaching of science in schools (Trna et al., 2012). One certain way to increase the number of students interested in studying science is to improve the way science is taught. In Tanzania, inadequate emphasis has been placed on enhancing the teaching of science in secondary schools, and this has resulted in not only poor performance on final examinations, but also in fewer students who are studying science (Kihwele, 2014).

This study on science education will be conducted in Tanzania. Therefore, it is important to examine the Tanzanian science education setting. Overall, a majority of students who are involved in science subjects (physics, chemistry and biology) in secondary schools are reported to fail (Mabula, 2012). A study conducted by Mabula (2012) revealed that students' results in these three subjects (physics, chemistry and biology) ranged from very few "C" grades to many "F" grades. Based on student learning assessments, general performance in science subjects is disturbingly low (Msoka, Mtebe, Kissaka, & Kalinga, 2014). The number of students dropping science subjects in secondary schools, particularly physics, in Tanzania has risen significantly. Kihwele (2014) indicated that there is extremely low interest in science subjects in secondary schools. A study conducted by Nyamba and Mwajombe (2012) discovered that the drop out ratio for optional science subjects was extraordinarily high.

The statistics reveal that 74% of students dropped physics in 2010 and 60% dropped chemistry (Mabula, 2012). Correspondingly, the pass rates in physics in secondary schools in Tanzania are persistently very low. For instance, the pass rate in physics was 26.3% in 2008 and dropped to 13.7% in 2011 (Ministry of Education and Vocational Training, 2012).

A number of studies have revealed that secondary education is headed for a crisis (Rweyongeza, 2012). Even though the decline in the quality of education in Tanzania is apparent at all levels of the educational system, the deterioration is most visible and highly publicized in secondary schools (King, 2013; Rweyongeza, 2012). Examination results released by the Ministry of Education for a number of years show massive failure in form four examinations (King, 2013). According to the Ministry of Education report (2012), in 2011, the results from form four students indicated that about 51% attained a zero in class (as cited in King, 2013, p. 54). Another report from the Ministry of Education (2013) showed that in the year 2013, 63% of students attained a zero grade (Ministry of Education, 2013, p. 55). Many secondary students in Tanzania find little interest in their science studies and frequently express their dislike of those subjects compared to other areas of study (Msoka at el., 2014). As a result, students perceive science subjects to be more difficult, unappealing, and irrelevant, and they are uninterested in science as personal career possibilities (Msoka et al., 2014).

A number of reasons are responsible for the root cause of such poor performance including: the lack of books and competent instructors, poor facilities, lack of teaching and learning materials, overcrowded classrooms, environmental and infrastructural problems for both teachers and students, shortage of laboratory facilities, as well as the language of instruction (King, 2013; Nyamba & Mwajombe, 2012; UNESCO, 2009; Vavrus & Bartlett, 2013). The government of Tanzania responded to these challenges by massively investing in education

(Ministry of Education, 2013), yet such efforts have still not translated into learning gains for students. Such experiences attest to the argument that performance in education depends on more than fulfilling the previously mentioned requirements. Student performance, especially in science subjects, heavily depends on the instructional method used (Wilen, 1990). Teachers with poor teaching approaches inhibit opportunities for their students to learn a subject (Ndalichako & Komba, 2014). The decline of interest in science subjects among Tanzanian students is caused by the way in which science subjects are taught and learned (Mabula, 2012). Weak teaching strategies may diminish students' readiness to learn science (Kihwele, 2014). A study conducted by Mabula (2012) revealed that the reason for the massive failure in science subjects was the teaching methods used by teachers. Science subjects are taught theoretically, which translates to a fact-transmission-oriented pedagogy. Teaching aims to quickly complete the goals of the syllabi rather than engage students in learning with the goal of helping students effectively grasp the science concepts (Mabula, 2012). The same study discovered that there is weak teacher-student classroom interaction, which could also reduce students' interests in science subjects and cause failure for students who desire to take science subjects (Mabula, 2012). This awareness is supported by Getzels and Thelen's (1960) suggestion that teacher-student interaction is a powerful force that can play a significant role in influencing the cognitive and effective development of students (as cited in Khine & Fisher, 2003). The interaction and interrelationships among teachers and students is vital in improving teaching and learning contexts (Khine & Fisher, 2003).

However, science instruction has changed with advancements in technology, and there is no in-service training or professional development opportunities provided to teachers to update them on new approaches and upgrade their pedagogical skills in teaching science (King, 2013;

Mabula, 2012). Secondary school teachers are not well trained in the use of appropriate pedagogies (UNESCO, 2009). These changes reduce teachers' motivations to teach and cause them to perform very poorly in their science classrooms. As a result, many students regard science subjects as difficult, and so, they drop out (Kihwele, 2014). Therefore, increasing teachers' efficacy and updating their teaching processes are necessary to overcome the challenges that Tanzanian schools are facing in science learning and teaching (Mabula, 2012). Appropriate instructional methods can motivate students and generate their interests in the process of acquiring scientific knowledge and skills (Barrow, 2006). This issue may be rectified by providing teachers with the necessary professional development opportunities to improve their teaching practices that will, in turn, motivate and prompt them to foster students' interests in science subjects.

Problem Statement

One of the reasons for the decline in Tanzanian students' interest in science subjects and increasing dropout rates is the manner in which science subjects are taught and learned (Mabula, 2012). Teachers use traditional teaching methods, which involve copying notes from teachers' lectures and offering explanations without giving students opportunities to ask questions (Mabula, 2012). This kind of teaching approach does not encourage students' involvement in their learning process. Vygotsky (1962) maintained that teaching of facts by either separating or disconnecting from practice will not lead to a full understanding of the concept the students are to learn. Vygotsky (1962) asserts:

> Direct teaching of concepts is impossible and fruitless. A teacher who tries to do this usually accomplishes nothing but empty verbalism, a parrotlike repetition of words by the

> child, simulating a knowledge of the corresponding concepts but actually covering up a vacuum. (p. 83)

Direct teaching may inhibit the development of critical thinking, because students learn by rote memorization rather than solving problems on their own. In such a classroom, students are passive as they listen, memorize facts, and reiterate the expected answers – skills that do not serve the needs of modern society – instead of being active recipients of information and developing problem-solving and critical thinking skills, which can help them when faced with issues in their studies, workplaces, and everyday lives.

An active learning method, such as the inquiry-based method, can be used to engage students in thinking critically, working collaboratively with peers in the classroom, and having discussions in small groups or even with the entire class (Saunders-Stewart et al., 2012).

The National Science Education Standards (NSES) defines inquiry as:

> A multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations. (p. 23)

Inquiry-based teaching has been affirmed to be an appropriate method for teaching science-based subjects (NRC, 1996). Inquiry-based science education (IBSE) is considered a successful and appropriate educational method that strongly motivates students (Trna et al., 2012). Schwab (1960) deemed that science should be taught in a manner consistent with the way in which modern science works; as such, he suggested that science be taught using an inquiry format. This method is student-centered, which means that students learn science by questioning, designing, and conducting investigations to answer questions, analyze data to construct explanations, and communicate their findings (NRC, 1996, 2000 as cited in Choi & Ramsey, 2009). This pedagogical method is suitable for Tanzania, where students learn science by memorizing facts and formulas instead of learning through experimental activities (Osaki, 2007; Semali & Mehta, 2012). Although inquiry-based teaching has been emphasized in Tanzania, most science teachers are still using teacher-centered methods of delivery (Kafyulilo, Rugambuka, & Moses, 2012; Paulo & Issa, 2013). Unfortunately, there is little evidence to explain why science teachers in Tanzania are not adopting inquiry-based teaching.

The inquiry-based method is capable of promoting motivation among students, because it generates interest in the process of acquiring scientific knowledge and skills (Gibson & Chase, 2002). In inquiry-based instruction, students are challenged to engage in activities that allow them to question, investigate, hypothesize, analyze, and conclude. In an inquiry-based classroom, the focus is on what the students are doing instead of the teacher. Students are doing the analytical work of making sense of the information given and producing scientific explanations.

The National Research Council (1996) advocates for inquiry instruction, because it mirrors the rationales presented by Vygotsky in that learning does not merely occur within the individual. Learning is a social and collaborative activity where individuals construct knowledge through their interactions with one another.

The science education community has placed a constant emphasis on inquiry-based teaching; however, there has been fairly little progress in its implementation (Kazempour & Amirshokoohi, 2014). In the classroom, science continues to be taught using teacher-centered instruction—direct transmission of knowledge and memorization of content (Kazempour & Amirshokoohi, 2014). Numerous teachers are not able to successfully utilize the inquiry-based instructional approach, because this method of teaching remains an abstract notion to them. Teachers did not encounter this approach in their own education and did not experience it during their training and preparation for becoming teachers (Kazempour & Amirshokoohi, 2014). Thus, transitioning to the inquiry-based approach to teaching science may be an intimidating undertaking which teachers struggle to implement (Kazempour & Amirshokoohi, 2014). In order to effectively adopt an inquiry-based approach to teaching and learning in the classroom, teachers are required to be familiar with both the nature of scientific inquiry and inquiry-based learning.

One of the causes which hinders the quality of teachers and the teaching process in Tanzania is the professional development of teachers (Mabula, 2012). Teachers are not provided with professional development options to aid them in developing new information on specific aspects of their teaching and to apply the knowledge and skills necessary to help students learn. Indeed, many teachers are teaching without updating their pedagogical competences, and this is very dangerous, not only to the teaching profession, but also to students' abilities to learn (Mabula, 2012).

Professional development is one method through which teachers develop the expertise necessary to enact inquiry-based practices in their classrooms (Lotter, Rushton, & Singer, 2013). Lotter et al. (2013) affirmed that when professional development designed to alter teachers' practices fails to take into account teachers' beliefs or how their beliefs are converted into practice, such programs are not successful. Professional development plays a vital role in teachers enacting an inquiry-based approach when teaching science to their students. It can function as a powerful tool to enhance instruction and teacher self-efficacy in science education.

A study conducted by Sottile, Carter, and Murphy (2002) found that teachers who enrolled and participated in science professional development showed improvement in their self-efficacy. At the end of the physics and integrated science and math professional development courses, the in-service teachers deemed they could motivate students to enjoy science and believed they were competent in answering questions about both math and science experiments. These in-service teachers believed they could plan their science lessons better by applying the constructivist approach and felt competent in their math and science achievements. In addition, with the skills they had acquired, these teachers believed they could help their colleagues in planning lessons and teaching. Therefore, this study revealed that when teachers are provided with professional development intended to increase the teachers' competence, there are corresponding changes in their instruction, which may be caused by the increased confidence or efficacy of the teachers in their abilities to comprehend math and science concepts. Positive social interaction and teachers networking with each other were also factors that motivated teachers to change their instructional methods (Sottile et al., 2002).

While students can construct knowledge in many diverse ways, inquiry learning gives students the opportunity to build onto their own existing knowledge schemas in meaningful ways (Lotter et al., 2013). Teachers' challenges with inquiry instruction are articulated as limitations; these may include not having sufficient time or instructional materials, not understanding how inquiry can be employed to teach the academic standards, or not having students who are developmentally or mentally able to succeed through inquiry (Lotter et al., 2013). Inquiry learning entails more student responsibility and freedom in a classroom setting (Lotter et al., 2013). In the course of inquiry instruction, teachers become inquirers along with their students, guiding and probing students who are often working in small cooperative groups (Lotter et al., 2013). Before beginning teaching, pre-service teachers need to learn the inquiry-based approach at the college level (Shamsudin & Yaama, 2013). Pre-service teachers who are taught to use the inquiry-based method are more likely to utilize hands-on activities in their classrooms (Shamsudin & Yaama, 2013). Such teachers are more likely to connect science experiments to everyday life.

As mentioned above, Kazempour and Amirshokoohi (2014) articulated that because many teachers were taught by lectures and were expected to be passive, only receiving information, they have constructed perspectives of learning as memorization of information and repetition of facts or concepts; moreover, to them, teaching would entail transmitting information and ideas to students. However, the constructivist theory claims the possibility of shifting from outdated methods of teaching and learning by promoting critical thinking and problem-solving.

In pursuing the social constructivist way of learning and teaching, there is a need for teachers to shift and transform their approaches to other teaching methods, because teachers would then become facilitators of learning, rather than merely being transmitters of facts or information. One of the ways for teachers to transform from traditional teaching methods to contemporary teaching methods is by participating in professional development programs. Guskey (2000) defined professional development as those processes and activities designed to enhance the professional knowledge, skills, and attitudes of educators so they might, in turn, improve the learning of students" (p. 16).

Guskey (2000) argued, "Educators at all levels must be continuous learners throughout the entire span of their professional careers" (p. 19). Thus, science teachers must be life-long learners through participating in professional developments, because professional development is designed to produce positive change and improvement (Guskey, 2000). Professional development can translate to teachers' improvement on their instructional practices by providing them with new knowledge and techniques, with the ultimate aim to enhance students' learning. This acquisition of knowledge, expertise, and professional growth is significant as it improves teachers' quality of instruction. As Glattenhorn (1987) stated, when teachers gain increased experience in their teaching roles they also gain increased experience in their professional growth by assessing their teaching abilities. Professional workshops, seminars, discussions, trainings, and meetings are a part of the professional development experience (Guskey, 2000).

A few studies revealed that various schools implemented inquiry teaching method programs for secondary school teachers in order to improve the quality of science teaching in their classrooms. In the first program, called the "Master of Arts in Teaching" program, preservice biology teachers are enrolled in classes for a year to learn different techniques for teaching science with the key focus being inquiry instruction (Binns & Popp, 2013). The second program is the "Physics by Inquiry" program, where teachers are taught teaching strategies by engaging in inquiry science activities and expanding their understanding of the science concepts that they usually teach (McBride & Bhatti, 2004). "As the teachers understand the process of science as inquiry, the teachers more eagerly teach the process to their students in the same way as they learned in the Physics by Inquiry program" (McBride & Bhatti, 2004, p. 434). In this program, teachers also attend inquiry workshops held in a physics laboratory, and the teacher educator leads the workshops. The workshop is aimed at extending teachers' understanding of the science content taught through inquiry-based science activities and helping the teacher to develop the skills necessary to interact with their students (McBride & Bhatti, 2004).

There are other workshops where teachers learn to foster understanding and belief in inquiry-based learning so that they can overcome obstacles in transforming from a “cookbook” lab (a method in which the students are told exactly what to do and how to do it) to inquiry-based labs (Bohrer, Ferrie, Johnson, & Miller, 2008). The purpose of this study is to indicate that there are slim chances for teachers’ participation in professional development options, and as a result, teachers still rely heavily on outdated teaching approaches to teaching science. Kazempour and Amirshokoohi (2014) conducted a study to investigate high school science teachers’ written reflections and assignments during an inquiry-based PD opportunity to explicate the process by which they learned about inquiry-based teaching. Basically, this study expanded an understanding of effective professional development by concentrating on teachers’ experiences, their beliefs and understanding, and their viewpoints on effective components of the professional development as uncovered by teachers through their written reflections and assignments during the professional development process. The results of this study showed that participants displayed enthusiasm and determination for modifying their teaching practices to better reflect a more realistic model of the process of scientific inquiry in their classrooms. In addition, participants felt increasingly more comfortable with adopting the inquiry-based instructional approach and anticipated the implementation of this approach upon their return to the classroom. Table 1 displays a summary of studies in which the implementation of the inquiry-based approach for professional development programs for science teachers improved their quality of teaching.

Table 1. Inquiry-based approach professional development programs for science teachers

Name & Year	Purpose of the PD program	Method	Findings
Binns & Popp, 2013	To explore the use of inquiry instruction from the perspective of the preservice teacher and to learn different ways to teach science, with one part concentrating on inquiry instruction.	Surveys and semi-structured interviews	Participants held positive views of inquiry instruction and anticipated its use in the classrooms
McBride & Bhatti, 2004	To train teachers in the strategies necessary for implementing an inquiry-based instructional program To increase teachers' understanding of the science content taught through inquiry-based science activities and to assist the teachers in developing the skills necessary in order to interact with students		The program was very successful in that teachers' achievement was revealed and passion about learning science through inquiry-based science increased.
Bohrer, Ferrie, Johnson, & Miller 2008	To learn methods, tools and resources used for training teaching assistants (TAs) to be more effective teachers. Help TAs to conceptualize and experience inquiry, practice using inquiry-based learning method in lab and reflect on outcome of an inquiry lab experience.	Survey, observation and focus group	Showed that TAs who are particularly trained to use inquiry or at least are teaching in an institutional setting that actively promotes it, utilize a wider range of teaching methods and tend to employ methods that promote inquiry more frequently than TAs who are not.
Kazempour, M., & Amirshokoohi, A., 2014	To investigate high school science teachers' written reflections and assignments during an inquiry-based PD opportunity to explicate the process by which they learn about inquiry-based teaching	survey, interview, and classroom observation	Participants showed excitement and determination to modify their teaching practices to better reflect the more realistic model of the process of scientific inquiry in their classrooms Participants felt increasingly more comfortable with adopting inquiry-based instructional approach and anticipated the implementation of this approach upon their return to the classroom

The studies above have demonstrated the positive effect related to inquiry-based teaching. Thus, teaching science through inquiry is the basis of good teaching. Unfortunately, an inquiry-based approach is still a new term in Tanzanian schools as most teachers are still using the traditional formats of teaching such as lectures. To date, there is little evidence to explain why science teachers in Tanzania are not adopting inquiry-based teaching.

Purpose of the Study

The purpose of this study was to (a) understand how the professional development learning experiences of Tanzanian secondary school science teachers influence their instructional practices, and (b) examine the approaches that science teachers utilize in the classroom, specifically the inquiry-based approach.

Research Questions

1. What kinds of professional development opportunities do science teachers receive?
2. What methods do Tanzanian secondary school teachers use to teach science to their students?
3. How do science teachers come to understand and make sense of what an inquiry-based approach means in teaching science?

Significance of the Study

Professional development is vital in bringing about transformation in teaching practices. This study may contribute to enhancing student learning of science in secondary schools in Tanzania. It may also suggest strategies for overcoming barriers to inquiry-based instruction. The study may help discover hindrances that affect teachers' abilities to adroitly acclimate to the classroom while striving to provide science education for students. This investigation may be significant to educators, especially those desiring to become inquiry-oriented teachers. Additionally, the results of this study may be beneficial in recognizing factors that promote successful science teaching. Educators who design, develop, and conduct trainings and professional development workshops or courses may find this study to be valuable as they may obtain information that may assist in developing future professional development activities. Understanding the obstacles, limitations, and successes science teachers experience when applying different teaching methods may inform course developers and instructors as they design and implement training and professional development courses. The research may be helpful in terms of determining what forms of professional development will be most beneficial for science teachers. Lastly, this study may be useful for Tanzanian teachers overall, as they will be cognizant of their abilities for self-realization in the classroom.

Overview of the Theoretical Framework

Despite the fact that there are many theories from which principles of learning can be drawn, social constructivism and sociocultural theories are of utmost importance. Odagboyi, Sambo, Musa, and Onche (2014) have supported this notion, saying: "knowledge is not just handed down to the learner from the teacher," but rather "knowledge is actively constructed by the learner" (p. 123). Many researchers and educators such as Gagne, Wager, Golas, and Keller (2005) and Schunk (2004) concur with this view by considering constructivism as a significant perspective from which efficacious teaching and learning can be applied.

Importantly, constructivists, such as Bruner (1996), Dewey (1916), and Vygotsky (1978), maintained that knowledge is constructed by individual learners through social interaction with others. Vygotsky put more emphasis on the social context of learning. The Vygotskian theory stresses the importance of the sociocultural environment in which learning occurs and how this context has an influence on what is learned (Vygotsky, 1978). Sociocultural theory highlights the central importance of interactions with people, including learners and teachers. This study is supported by, and falls within, the social constructivism epistemology and sociocultural theory advocated by Vygotsky (1978). Sociocultural theory informs us that the development of the mind is embedded in personal interaction with society, and teaching that involves facilitating new ways of thinking plays a role in contributing to the development of human consciousness (Vygotsky, 1986). Social cultural theory highlights that the act of individuals interacting with one another is a key element in the development of knowledge.

We are positioned within a social context, and therefore, we share our lives with others. Thus, social interaction helps us to construct knowledge of the world around us. From this perspective, knowledge construction is processed within people's minds as a result of social interaction. This means knowledge is constructed socially, because individuals negotiate knowledge with others in a social context, and as a result, meaning is shared through and among people who interact with each other. Therefore, as individuals communicate and interact with one another, knowledge is constructed.

The primary conceptual framework for this study is the social constructivism theory. Social constructivism is based on Vygotsky's socio-cultural theory, which maintains that knowledge is co-constructed and that people learn from each other (1978). This theory's main assertion is that social interaction plays a vital role in the development of cognition (1978). This theory is called "social constructivism," because Vygotsky believes that learners must engage in the learning process and that learning occurs with the help of other people. Hence, this is where the social aspect of the theory is derived. In the following section, I will explain Vygotsky's theories as they relate to the teaching and learning of science in Tanzania.

Sociocultural Theory

As with constructivist learning theories, sociocultural theory also proposes that learning is an active process and that the context has a vital role in learning. The sociocultural theory is derived from the works of Vygotsky (1978) and incorporates the role of society in teaching and learning. Sociocultural theory is grounded on four central assumptions about learning regarding this study: (1) a person develops or learns through active engagement with others within a specific sociocultural context, (2) human action and interactions are mediated by tools and signs that shape human development, (3) a teacher of expert adults facilitating learning within the learners' zone of proximal development (ZPD) assists and guides learners in attaining competence in skills and knowledge valued by the society, and (4) achieving mastery or assimilation of these tools is a principal objective of learning.

When integrating constructivist theories, sociocultural theory shifts its emphasis to the manner in which meanings are built through language in the context of science classrooms. From this viewpoint, the context in which learning occurs is descriptive of a group and a culture that has its own way of perceiving and understanding the world (Vygotsky, 1978). In other words, the sociocultural theory emphasizes the social and cultural contexts of students' thinking (Vygotsky, 1978).

It is a theory of knowledge that integrates the philosophical base of constructivism into a social setting whereby, in groups or teams, individuals construct knowledge with one another, cooperatively forming a culture of shared efforts with shared meanings. According to social constructivists, knowledge cannot be acquired by an individual, but it can be achieved through social processes (Leach & Scott, 2003). Sociocultural theory maintains that a teacher's role is not to transfer knowledge to the students, but to encourage students to construct their knowledge through negotiation within their social settings (McLaughlin, 2001). This implies that students' learning develops through social interaction and discussions in which students progressively grasp others' knowledge and co-construct new knowledge.

This theory suggests that teachers need to take an active role in stimulating learning by creating social and cultural experiences in their classrooms. Vygotsky indicated that students learn through participating in and sharing another person's frame of reference; hence, a teacher who undertakes a highly interactive task with students challenges them to succeed. Vygotsky employs social interaction as the framework for learning and development.

Vygotsky (1978) observed the significance of learning in social settings and the effect of the support of more skillful individuals on the development of the learner. He asserted that children rely on the modeling and skills of adults and more capable peers to progressively develop capabilities to complete tasks, such as discussing a scientific concept or solving a chemistry problem. The social aspect of cognitive development is included in the notion of intersubjectivity, which signifies a shared, mutual understanding amongst members in an event or activity (Vygotsky, 1978) and the creation of a shared understanding between the learner and the teacher (Wertsch, 1985)

Thus, in the teaching and learning processes, a teacher should be a facilitator and not an instructor. The role of the teacher is to provide support so that the students can undertake the task and arrive at a high level of learning which the students alone could not accomplish. In this regard, the teacher is providing the appropriate assistance to elevate students so they can achieve the task, and this is the zone of proximal development.

According to Vygotsky, students' learning is first determined by signs and tools in their contexts (Vygotsky, 1986). This implies that learning materials and activities should be contextualized, meaning they should be pertinent and relevant to the students' daily lives. Teachers should provide students with authentic tasks in a meaningful context and act as a guide, as constructivist learning emphasizes students actively completing their work rather than being merely passive learners. Therefore, from this perspective, classroom interaction is very crucial, because it engages students to interact with their teachers, peers, and learning materials to construct their knowledge. Hence, in the teaching and learning of science, interaction may be hindered by the teacher, students or even tools, such as teaching and learning resources, and this can negatively affect the teaching and learning processes.

Although the work of Vygotsky largely focused on children, similar processes and practices take place in adult learners. Therefore, the interactions amongst more well-informed persons such as peers, teachers, mentors, and adult learners turn into significant phenomena for study in sociocultural learning.

Chapter Summary

In this chapter, I presented an overview of the study and its purpose and research questions. I also provided the background of the theoretical framework, the significance of the study. The main purpose of the study is to (a) to understand how the professional development learning experiences of Tanzanian secondary school science teachers influence their instructional practices and (b) to examine the approaches that science teachers utilize in the classroom, specifically the inquiry-based approach. The central research questions are 1. What kinds of professional development opportunities do science teachers receive? 2. What methods do Tanzanian secondary school teachers use to teach science to their students? 3. How do science teachers come to understand and make sense of what an inquiry-based approach means in teaching science?

CHAPTER 2

REVIEW OF THE LITERATURE

This study examines how the professional development learning experiences of Tanzanian secondary school science teachers influence their instructional practices, and also it investigates the approaches (specifically, the inquiry-based approach) that science teachers utilize in the classroom. This chapter provides an overview of the relevant literature that guided and informed this study and focuses on the professional learning needs of science teachers. This review employs the social constructivist theory as the theoretical framework. This review highlights the theory that contributes to the development of "inquiry approach pedagogy," which is generally considered to be an effective method for teaching science.

The chapter also provides a definition of the term *inquiry* and describes levels of inquiry. Moreover, the benefits and challenges of using the inquiry-based approach are explained, and various ways in which science teachers come to learn the inquiry-based approach are illustrated. The chapter emphasizes the importance of incorporating the principles of adult learning into professional development programs designed for science teachers. Ultimately, the review will highlight professional development as a way for teachers to learn and improve their instructional strategies and practices with the ultimate goal of improving student achievement.

Sociocultural Theory

The theoretical frameworks for teacher professional development investigated in this study fall within the realms of the social constructivism theory. The context of this study involves Tanzanian science teachers in a secondary school. The social constructivist learning theory is based on Vygotsky's (1978) developmental theory which explains how human beings learn. Vygotsky (1978) alleged that the accumulation of knowledge is not an isolated experience. He proposed that knowledge is not merely transferred from one individual to another but it is socially constructed through interaction with others. Therefore, social interaction plays a crucial role in the development of cognition.

According to Bonk and Cunningham (1998), a key principle of Vygotskian psychology maintains that "individual mental functioning is inherently situated in social interactional, cultural, institutional, and historical contexts. Therefore, to understand human thinking and learning, one must examine the context and setting in which that thinking and learning occurs" (p. 35). Therefore, collaborative learning resides at the center of this theory. Vygotsky declared that learning is first meditated by tools and symbols within their contexts. For this reason, learning activities and materials occur in cultural contexts. In other words, learning should be contextualized so that the learning process is applicable to the daily lives of students.

Secondly, learning develops through social interaction, where students progressively grasp others' knowledge and co-construct new knowledge. The major methods in this notion include collaborative learning and communication (Bonk & Cunningham, 1998). Thirdly, students need assistance from experts (these could be teachers or mentors) to help them perform beyond their current capabilities and reach higher levels of learning (Bonk & Cunningham, 1998). Vygotsky affirmed that children rely on the modeling and skills of adults and more knowledgeable peers to gradually develop abilities in order to perform tasks such as solving problems. Therefore, learning activities in sociocultural settings are categorized by active engagement, problem-solving, and collaboration with others.

According to Vygotsky (1978) and other sociocultural theorists such as Wertsch (1998), the social aspect of cognitive development is captured in the notion of intersubjectivity. The term intersubjectivity refers to “the degree to which interlocutors in a communicative situation share a perspective” (Wertsch, 1998, p. 111). In other words, this concept translates to a shared understanding and mutuality among learners who participate in an activity or event. The sociocultural perspective offers vast influences for schooling, teaching, and education as a whole (Tharp & Gallimore, 1988). Although the work of Vygotsky primarily focused on children, similar practices occur with adult learners, including science teachers. Therefore, the interaction and dialogue between experts–who possess more knowledge on a particular subject–and adult learners becomes a significant phenomenon for researching sociocultural learning.

Professional Development

Historically, teachers’ professional development was connected with the Teacher Institutes of the early 19^{th} century (Richey, 1957). At that time, teachers’ professional development was referred to as “in-service education.” The professional development efforts during that era were characterized by disorder, conflict, and criticism (Guskey, 1986, p. 5). During that time, professional development for teachers was seriously needed; however, the professional development activities were “uninspiring and ineffective” (Corey, 1957, p. 1). In the first few years of the twentieth century, Corey (1957) reported that teachers who worked at common schools were “immature, poorly educated and superficially trained” (p. 2). Thus, the aim of in-service education was to rectify such shortcomings, and teachers’ institutes became the primary resource for achieving that goal. Professional development mostly stressed simply adding new skills and knowledge without taking into consideration the importance of assisting teachers in rethinking and discarding—or at least changing—thinking and beliefs (Loucks-

Horsley et al., 2010). With that, many teachers reported that this type of practice overwhelmed them with many new issues that they needed to understand (Loucks-Horsley et al., 2010).

According to Loucks-Horsley et al. (2010), in the early 1970s professional development was known as “in-service training,” and its aim was to bring external expertise to increase teacher knowledge. Professional developers were regularly referred to as “trainers,” and they generally used lectures and, at times, demonstration of practices as their teaching and learning tools. Providentially, such practices have significantly changed; however, remnants of the old model still exist (Loucks-Horsley et al., 2010). Presently, considerable research has been carried out to examine high quality and effective professional development events as well as various forms of professional development that produce change in teachers’ instructional practices.

Substantial research has been carried out on teachers’ professional development. Guskey (2000) defined *professional development* “as those processes and activities designed to enhance the professional knowledge, skills, and attitudes of educators so they might, in turn, improve the learning of students” (p. 16). One of the attributes of professional development is that it should be continuous. Cwikla (2004) attested that “Professional development refers to teachers’ ongoing learning and their development in the profession, not simply to an in-service day of workshop or summer training” (p. 321). This contention is supported by Guskey (2000), who specified that professional development should not be an event that occurs during only 3 or 4 days of the school year. In such as a case, teachers’ opportunities would be severely limited. According to Loucks-Horsley et al. (2010), professional development should be a series of interconnected, sequential learning experiences rather than independent, disconnected workshops that last for short periods of time. Ultimately, Corcoran (1995) concluded that teachers are not likely to develop the knowledge and skills that are required to teach high standards or to utilize constructivist teaching strategies by merely participating in a few days of professional development.

The terms *personal and individual development*, *staff development*, and *professional development* are often used interchangeably (Trorey & Cullingford, 2002). Terms such as *continuing professional development*, *in-service learning*, *in-service education*, and *in-service training* are also often used interchangeably (Craft, 2000). However, all these phrases can signify and translate to many types of learning carried out by teachers beyond their initial training (Craft, 2000).

Guskey (2000) summarized the professional development notion by outlining its three key features: “intentional, ongoing, and systematic” (p. 16). Firstly, professional development that is designed for science teachers should have a well-organized plan and clearly defined goals concerning the subject-matter intended to be addressed. By creating a clear plan, “a set of random unrelated activities that have no clear direction or intent” (Guskey, 2000, p. 17) can be avoided. Secondly, professional development is an ongoing process given that individuals’ knowledge develops on a daily basis. Many studies have revealed that professional development activities must be continuous, ongoing, and long-term. As a result, the duration of the activities and the number of hours participants are involved in per year must be reasonable (Desimone, 2009; Odden, Archibald, Fermanich, Gallagher, 2002).

Professional Development of Teachers

Teachers are the foundational aspect of any educational system, and it is imperative that teachers be provided with suitable and effective training (Beaver, 2009). Teachers are one of the most important factors affecting student learning (Wright, Horn & Sanders, 1997). They need extended time to remain well-informed about an ever-increasing knowledge base and to expand their abilities and skills (Guskey, 1998). Teacher professional development must focus on improved student learning outcomes (Bredeson & Johansson, 2000). According to Loucks-Horsley, Stiles, Mundry, Love, and Hewson (2010), through professional development opportunities teachers are able to develop and expand their knowledge of subject content, assessment strategies, and instructional strategies. These opportunities to progress professionally not only benefit teachers by allowing them to enhance their abilities but also help ensure that best practices are utilized daily and that the most effective methods are employed (Renyi, 1996).

Professional development is regarded as a vital mechanism for deepening content knowledge and developing teaching practices (Desimone, Porter, Garet, Yoon, & Birman, 2002). Guskey supported the notion of professional development when he affirmed “educators at all levels must be continuous learners throughout the entire span of their professional careers” (p. 19). Thus, science teachers must become life-long learners by participating in professional development which is designed to produce positive change and improvement (Guskey, 2000).

According to Guskey (1986), professional development is a focal element in almost every scheme for improving education. When teachers participate in the design, delivery, and content of professional development, the results are most likely to meet the needs of teachers and to produce a significant effect on teachers’ thinking as well as their classroom practices (Bredeson & Johansson, 2000). That is to say, professional development programs represent a systematic effort to produce change: shifts in teachers’ practices in their classrooms, changes in their beliefs and attitudes, and changes in the learning outcomes of students (Guskey, 1986).

All teachers must continually learn in order to keep up with advances in subject matter and in the theory and practice of teaching (Hass, 1957). Professional development ensures that teachers continue to enhance, grow, and transform. To truly improve teachers’ instruction, it is critical to invest in creating and sharing knowledge. This can be accomplished by providing teachers with the opportunity to learn about teaching (Stigler & Hiebert, 1999). In order for students to learn more, teachers must transform the manner in which they teach (Odden et al., 2002). If teachers are expected to play a key role in improving instruction, then they need to be provided with an atmosphere in which they are able to perform their work effectively. In this case, professional development can be used as a tool to improve teachers' instruction. Professional development helps improve pedagogical knowledge as well as the subject expertise of teachers' learning (Trorey & Cullingford, 2002). Thus, to change teachers' practices involves analyzing the old and new practices, crafting the appropriate adjustments, and learning to undertake new practices effectively (Stigler & Hiebert, 1999).

Teachers are expected to be informed of new knowledge, tailor instruction for a diverse population of students, and introduce new technologies into the classroom and more; however, teachers feel pressured in terms of time and opportunities to learn (Renyi, 1996). Indeed, teachers should not be expected to implement improved teaching methods without being given the opportunities to acquire such methods (Stigler & Hiebert, 1999). According to Corcoran (1995), the culture in most schools discourages open discussion of classroom problems by teachers, and this results in embarrassment when teachers try new methods or even when they discuss their experiences with their peers. If teachers are expected to apply new strategies of teaching, they must be protected from the negative social and professional consequences that may result when they attempt to transform their practices, and they should be forewarned that they may bump into failure along the way to improvement (Corcoran, 1995). Therefore, teachers require consistent professional development opportunities over long periods of time to learn and enhance their instructional practices as well as those of their colleagues (Stigler & Hiebert, 1999).

While some researchers believe that participating in the professional development, teachers can enact considerable changes in the classrooms. Thurlings, Evers and Vermeulen, (2015) revealed that there has been no consideration of the role of professional development as an influence for innovation, in other words, quality improvement in educational institutions. In a review study, Thurlings, Evers & Vermeulen, (2015) presented the basis for understanding influences that enhance innovative behavior in educational institutions. They concluded that demographic, individual and organization are factors that influence teachers' innovative behavior. For demographic factors, age and gender were stated. In terms of individual factors, personality, trait and competence were classified. Regarding organizational factors, relationships with other individual such as colleagues and supervisors, facilities and resources, culture, physical characterizes of the organization etc. were distinguished (Thurlings et al., 2015).

As presented by Thurlings et al., (2015), reasons such as rapid technological and social changes in the society, stress the necessity for innovative teacher behaviors. Teacher innovative behavior is highly important for the further development of educational professional, educational institutions and for the individuals' development as a knowledge society (Thurlings et al., 2015). Generally, teachers can provide valuable insight pertaining the factors that can promote change in educational institutions, ways in which innovative behavior can be improved in schools so as to produce best results and importantly, ways in which innovative behavior can contribute to the society as a whole. For this reason, innovative behavior should be central to teaching profession (Thurlings et al., 2015).

Types of Professional Development

The numerous types of professional development range from mentoring or tutoring, using distance-learning materials, receiving and/or giving on-the-job coaching, peer networks, school-based and off-site courses of various durations, school cluster projects that involve collaboration, development, and sharing of experience/skills, personal reflection, and collaborative learning (Craft, 2000). Other forms of professional development include training, observation/assessment, study groups, and individually guided activities. However, training is the most common form of professional development, and it includes discussions, large group presentations, workshops, seminars, demonstrations, colloquia, role-playing, simulations, and micro-teaching (Guskey, 2000).

Training

The main drawback of training is that it offers limited opportunities for choice or individualization. Therefore, training may not be appropriate for groups of educators with differing level skills and expertise. Training sessions must also be lengthy, appropriately spaced, and accompanied by further follow-up activities so as to provide feedback for further learning and coaching, which are necessary for the effective implementation of new ideas (Guskey, 2000).

Observation

Observation is one type of professional development activity. Guskey (2000) considers observation to be one of the best ways to learn. An individual can acquire knowledge by observing others or by being observed and receiving feedback. When individuals use this form of professional development, they examine and reflect on the information learned and as a result, gain professional growth, which can be valuable to their professions (Guskey, 2000). Observation or assessment as a professional development practice needs to be reciprocal to provide peers with feedback on their performance (Guskey, 2000). Observations of classroom teachers may be a good example of this type of professional development activity as a teacher may observe the design of the lesson, classroom management, instructional practices, or other teaching techniques (Guskey, 2000). When teachers observe other teachers, they may be able to visualize new possibilities for their own teaching (Stigler & Hiebert, 1999). This form of professional development can assist teachers in identifying their strengths and areas in which they need improvement or even transformation.

One-shot Workshops

One-shot workshops are professional development activities which last from 1 to 3 days. These 1- to 3-day workshops, courses, and seminars do not address the needs of teachers who seek up-to-date approaches and instructional strategies (Johnson, 2006). Such short-term professional development events have been criticized throughout the literature. For instance, Dass and Yager (2009) stressed that teachers' abilities to utilize strategies that promote active learning cannot be developed through brief, one-shot professional development sessions. Teachers require carefully planned, continued professional development opportunities that actively engage them in the learning process (Dass & Yager, 2009).

Teachers often attend workshops or seminars but are not provided with any genuine follow-up or sustained support of what was learned (Guskey & Yoon, 2009). According to Guskey (1986), these types of workshops are often isolated and ineffective in helping to enhance teaching practices in the classroom. Many educators consider these one-shot workshops a waste of money and time (Guskey & Yoon, 2009) as they do not result in long-term change in the classroom (Guskey & Huberman, 1995).

Individually Guided Activities

Another form of professional development is *individually guided activities.* In this professional development effort, teachers decide what they want to do for their own individual professional development goals and then choose activities that they consider will produce the desired outcomes (Guskey, 2000). This model is grounded in the notion that individuals can best assess their own learning needs and are able to apply self-direction and self-initiated learning (Guskey, 2000). In terms of the benefits of individually guided activities, Guskey (2000) indicated that this form of professional development leads to personal reflection, thoughtful decision-making, and self-analysis.

An individually guided activity model of professional development is flexible as it offers various opportunities for teachers to participate in self-analytic and self-reflective kinds of activities, such as conducting personal histories, video-/audio-recording self-assessments, and writing journals. A drawback of an individually guided professional development model is that the process of collaboration or the sharing of information among teachers may be restricted because of the individualized nature of professional development. Educators who wish to practice this type of professional development have to ensure that their goals are adequately challenged and meaningful and that they are connected to specific enhancements in professional practice and improved student learning (Guskey, 2000).

Collaborative Learning

Collaborative learning is also a professional development activity. Teachers undertake professional development by working with colleagues on a defined task or issue (Kraft, 2000). Although this type of professional development is underrated, it can produce a positive outcome since teachers have an opportunity to learn from each other's successes and failures, which leads to professional growth and learning for an individual teacher, groups, and schools as a whole (Kraft, 2000). Collaborative learning as a way of improving teachers' instruction is also emphasized by Loucks-Horsley et al. (2010), who stated that teachers need to engage with their colleagues in conversations or dialogues to learn from one another, examine examples of practice and reflect on their own practices as well as their students' learning to become experts of effective strategies.

Learning together as a group, which involves teachers, administrators, and staff, leads to an appreciation of individual differences, as people involved become more cognizant of others' viewpoints and more skilled in group dynamics (Guskey, 2000). Individuals who engage in this type of professional development usually have a keen interest in the issues or problems addressed, and therefore, they are devoted to discovering effective solutions (Guskey, 2000). A limitation of the development or improvement process is that participation is normally limited to a fairly small number of staff members (Guskey, 2000). It is also important that a professional development model, which involves a group of people, be balanced in a way that everyone's ideas or contributions are valued, rather than one person having a greater chance of conveying his or her thoughts and ideas to the group.

Involvement in a Development or Improvement Process

Involvement in a development or improvement process is also a model of professional development which not only gives educators an opportunity to acquire new knowledge and skills but also provides opportunities to discover solutions to problems by collaborating with colleagues through discussion. An example could be teachers gathering to develop or review a curriculum, design a new program, plan strategies to improve instructions, or solve a specific issue (Guskey, 2000). The benefits of involvement in a development or improvement process are that teachers expand their specific knowledge and skills while improving their ability to work collaboratively and share in decision-making.

To summarize, these forms of professional development describe practices that have important components. Clearly, professional development should be collaborative, have follow-up events, should be constant and provide continuous growth, and should involve the daily practices of teachers.

Where Should Professional Development Take Place?

Professional development for teachers has to occur not only inside but also outside the school (Lieberman, 1995). There are some professional development programs consisting of networks, coalitions, partnerships and collaboratives, and these provide opportunities that vary in quality and style from those that are offered inside the school or in traditional professional development programs (Lieberman, 1995). Most of the professional development approaches are "one size fits all" (Lieberman, 1995, p. 594); however, those professional development strategies, which make opportunities available for orientations, networks, partnerships and coalitions, allow teachers to commit themselves to subject matters that are of essential interest (Lieberman, 1995).

When teachers participate in such professional development events, they are capable of developing stronger voices to convey their viewpoints, learn from and with their peers, and utilize their firsthand experience to build new possibilities for students by working collaboratively. Additionally, these teachers create a community of shared understanding that enhances their teaching and provides them with intellectual and emotional motivation (Lieberman, 1995). In such a setting where collaboration and partnership are exercised, teachers learn together, ask questions and discuss their teaching practices, their successes, and the challenges imposed by implementing improved approaches in a nonjudgmental and safe atmosphere.

Therefore, teachers must participate in active learning, e.g., by interacting with their colleagues frequently to discuss their own efforts so as to acquire a deeper understanding of their own instructional practices as we well as their students' learning (Desimone et al., 2002). Effective professional development requires sufficient time for educators to develop, practice, and reflect on new concepts and skills in support of and in collaboration with their colleagues (Guskey, 1998). This notion is supported by Renyi (1996), emphasizing that teachers need time to master new knowledge and work with colleagues collaboratively in order to expand the knowledge they already have. They also need flexible scheduling and prolonged duration, i.e., a year or so, to incorporate professional growth into the structure of the school day.

In addition, teachers need sufficient time to develop expertise in applying information technologies to build new paths to knowledge for students (Renyi, 1996). In so doing, teachers engage in the collective development and growth of other teachers for the purpose of effectively serving the educational needs of their students. A vital aspect of this effort is maintaining a focus on continuous enhancement and growth both as a teacher and as an individual through collaboration, reflective practice, decision-making, and engagement. In summary, Renyi (1996, p. 16) identified several key characteristics of professional development that support 21st century skills, shifting from narrowly focused teacher professional development to modern ways of learning shown in Table 2.

Table 2. Shifting Emphases in Teacher Professional Development

From	To
Isolated, individual learning	Learning both individually and in the context of groups, such as the whole school faculty and teacher networks interested in particular subjects
Fragmented, one-shot "training"	Coherent, long-range learning
District level, one-size-fits-all programs	School-based learning tailored to the needs of all the students in the building
Bureaucratically convenient	Focused on student needs
Outside the workplace	Embedded in the job and closely related to both student and teacher needs
Experts telling teachers what to do	Teachers taking an active role in their own growth
Skills that can be used by everyone and therefore available in-depth to no one	Involvement of all teachers and instructional leaders in developing new approaches to teaching based on their needs
Teachers as passive receivers	Teachers and administrators as active makers of their own learning
Adult learning as an add-on that is not essential to schooling	Adult learning as a fundamental way of teaching and a transformation of schooling
Measuring effectiveness by attendance at workshops	Measuring effectiveness by improvement in teaching and learning

The National Science Education Standards envisioned change throughout the system. The change emphasizes in science education content delivery and promoting inquiry as proposed in the National Science Education Standards. Table 3 below shows the professional development standards encompass the changes (NRC, 1996, p. 72).

Table 3. The Professional Development Standards

Less emphasis on	More emphasis on
Transmission of teaching knowledge and skills by lecture	Inquiry into teaching and learning
Learning science by lecture and reading	Learning science through investigation and inquiry
Separation of science and teaching knowledge	Integration of science and teaching knowledge
Separation of theory and practice	Integration of theory and practice
Individual learning	Collegial and collaborative learning
Fragmented, one-shot sessions	Long-term coherent plans
Courses and workshops	A variety of professional development activities
Reliance on external expertise	Mix of internal and external expertise
Staff developers as educators	Staff developers as facilitators, consultants, and planners
Teacher as a technician	Teacher as an intellectual, reflective practitioner
Teacher as a consumer of knowledge about teaching	Teacher as a producer of knowledge about teaching
Teacher as a follower	Teacher as a leader
Teacher as an individual based in a classroom	Teacher as a member of a collegial professional community
Teacher as a target of change	Teacher as a source and facilitator of change

As shown in the tables above, the National Science Education Standards shifted the emphasis in science teaching and proposed that professional development efforts should have the following characteristics: they should be long-term and put less emphasis on separating theory from practice and more emphasis on integrating them. Instead of relying only on external expertise, the standards propose that there should be involvement of teachers, trainees, and consultants with particular expertise and experience. In addition, the professional development should focus on improving the knowledge of the science teacher. Importantly, professional development educators should not be regarded as *experts* but should act and serve as facilitators, consultants, and planners. In the standards, teachers are viewed as leaders rather than followers.

Finally, teachers are considered as a source and facilitator of change rather than being the *target* for change.

Furthermore, Table 3 gives a summary of how professional developers should be prepared to apply constructivists' instructional methods to teacher professional development events. These teaching qualities of professional development included in the NSES can lead to the continued growth of science teachers. These qualities are significant and required for professional development programs intended to prepare and train science teachers. Evidently, there should be less emphasis on lecture and memorization but more on active inquiry, discussion, teacher collaboration, cooperative learning, and continuous professional development opportunities for teachers; also, students' experiences should be used as tools for learning. The standards do not support the direct transmission of information and skills by teacher to students—this traditional way of teaching and learning is discouraged.

Challenges in Professional Development

Policy-makers and course developers face several challenges as they seek to put theories into practice to enhance professional development opportunities for teachers. They encounter obstacles such as funding, time, the setting of priorities, incentives, teacher attitudes, and public support (Corcoran, 1995).

Time

For a long time, professional development advocates have been distressed about the insufficient time teachers are afforded to participate in professional learning (Guskey & Yoon, 2009). Time is the foremost challenge (Corcoran, 1995). Indeed, time is required to plan and develop professional learning opportunities for teachers to interact with colleagues about their practices, to try new strategies, and to integrate changes into their professional practices

(Corcoran, 1995). Teachers need time to deepen their understanding, analyze students' work, and develop new instructional methods (Guskey & Yoon, 2009). Time is a key factor for success; allotting time for professional development and not using the time sensibly would translate into no gain (Guskey & Yoon, 2009).

Professional development requires substantial time, and such time must be well-planned, logically organized, and concentrated on content and instruction (Guskey & Yoon, 2009). According to Corcoran (1995), time could be given during a school day; however, this may lead to hiring more teachers, because emancipating teachers from their obligations or reducing curricular options or services could bring up other issues from parents. If the school day is to be extended, it may lead to pressure for increased compensation for teachers. After all, putting teachers together at the end of their duties after a long day of teaching may barely produce a positive outcome in terms of having a constructive discussion (Corcoran, 1995).

Funds

Professional development must be planned carefully to make the greatest impact possible on teachers as well as students. Teachers' professional development opportunities may be challenging, because they certainly require money (Corcoran, 1995; Odden et al., 2002). Conversely, if teachers are expected to change, enhance their practices, keep up with updated knowledge, take more responsibility for their instruction, and work collaboratively with their peers, then there should be an investment in professional development. Funding plays a part in planning for the professional development of teachers; it must be allocated for the purpose of supporting teachers' development. Thus, it is imperative to keep this factor in consideration when planning for professional development opportunities for teachers.

Support and Feedback

In order for professional development efforts to be successful, support and feedback are necessary. Professional development is intended to provide opportunities to share, evaluate and reflect on the results. Teachers learn from their peers through sharing experiences and the results of their practices, and they are encouraged to continue the efforts by practicing and honing what they have learned. This style of feedback and follow-up support promotes the development of a community of learners (Dass & Yager, 2009).

Professional development experts have emphasized the importance of follow-up activities. According to Guskey and Yoon (2009), nearly all of the studies that revealed positive improvement in students' learning involved substantial amounts of structured and continued follow-up after the primary professional development events or activities.

Teacher Attitudes

Many teachers consider that the professional development events that they attended and experienced have produced little practical use. Teachers' attitudes regarding professional development and their motivation to pursue opportunities for professional growth are influenced by their prior experiences (Corcoran, 1995). This is a challenge, because sometimes teachers' expectations are low, and they will attend the professional development programs to merely be entertained and utilize professional development time for socializing with their colleagues (Corcoran, 1995). These teachers must be convinced that professional development can help them enhance their instructional practices. Unfortunately, it may be difficult to persuade some teachers that new approaches of professional development may work better than the old ways and that they may acquire more knowledge from participating in those programs.

Incentives

Some teachers, specifically those who need persuasion and support to participate in professional development opportunities, may be offered incentives that may boost their motivation to participate. According to Craig, Kraft, Plessis (1998), professional development programs should provide sufficient incentives to attract and retain teachers. These incentives can be in the form of monetary, food, transportation etc. and must correspond with the needs of teachers if they are to be authentic incentives.

Planning Learning Programs for Adults

When professional development providers deliver lessons to teachers, it is critical that they consider the instructional delivery methods as well as the principles of how adults learn. According to Beavers (2009), by integrating the adult learning principles, teacher professional development can significantly increase its effectiveness. As Loucks-Horsley et al. (2010) reinforced, professional development programs for teachers “require adapting the material to meet conditions of adult learning” (p. 73). Teachers are often distressed with the facilitators or presenters’ styles and format of the lessons, and useful information is overlooked and disregarded because of the poor teaching strategies implemented by the presenters or facilitators (Beavers, 2009). One of the requirements for effectively educating teachers is to actively regard adults as unique learners and recognize that each individual teacher has different needs. The providers of teacher professional development must also respect teachers’ individuality and give them opportunities for self-direction (Beavers, 2009). Importantly, adult education principles must be incorporated into the programs delivered to the teachers (Beavers, 2009).

Caffarella (2002) developed a model named "Interactive Program Planning Model" which clearly integrates strategies that can be used to facilitate learning transfer in program planning. Caffarella views planning as a dynamic process that can be influenced by various factors such as social issues, institutions, economics, and politics; therefore, interactive program planning is non-linear, which means that there is no clear place to begin or end in the planning process. It was designed for program planners to begin at any point and organize their thoughts (2002), thereby allowing flexibility. Thus, program planners for adults may find all of the components are applicable for planning an educational or training program or they may choose to apply the relevant parts of the model in any order they desire depending on the program (Caffarella, 2013). Basically, the program planners are mainly in charge of the lessons the learners will be learning but the learners can be involved in the process at certain phases.

According to Caffarella (2002), some education and training programs are carefully planned while others are plainly thrown together. Program planners must ensure the program they develop meets the needs of all stakeholders, reflect on their own beliefs and values, and become lifelong educators to fulfill stakeholders' needs. Program planners must consider their own assumptions prior to using the Interactive Model. According to Caffarella (2013),

> Before planners decide to try the Interactive Model, [and] they should examine their own beliefs about planning programs for adults to determine whether the model fits with who they are and how they prefer to practice. If, for example they are unwilling to negotiate with other parties in the planning process, the Interactive Model of Program Planning will not work for them. (p. 37)

Importantly, program planners must take into consideration the social, political, economic, technological, and other external factors that influence the needs and interest of and for teachers as adult learners. The process of designing an educational program involves establishing goals and objectives when planning an evaluation process, developing instructional design, and organizing learning procedures.

Since teachers are adults learners, understanding how teachers learn in critical. Cafferela's (2002) model of program planning is consistent with the adult learning principles developed and proposed by Knowles' (1980). Malcolm Knowles proposed the learning theory of andragogy which helps to distinguish adult learners from children. The study of how children learn is called "pedagogy," whereas "andragogy" is the art and science of helping adults learn (Knowles, 1980, p. 43). Andragogy is a learning theory intended to address the specific needs of adults, and it is grounded on the notion that there are substantial differences in learning between children and adults (Knowles, 1980). Consequently, this model acknowledges that as a person matures, his or her self-concept moves from that of a dependent personality toward one of a self-directing human being. Because each individual is unique, the pace in which self-directed learning takes place may vary among individuals, and some individuals may need to be directed specifically when a new notion is presented. The model follows that adults accumulate experience, which is a rich resource for learning (Caffarella, 2002; Craig, 1996; Knowles, 1980). As a person matures, she or he accrues experience that becomes beneficial and a resource for learning. When individuals experience learning, it is more practical and meaningful to them. The model recognized that the readiness of an adult to learn is closely related to the development tasks of his or her social role. The learner knows when she or he is ready to learn, when she or he recognizes there is a need for new learning, and acknowledges how the learning will be applicable to real-life problems. In this case, professional development should have immediate relevance to and impact on teachers' professional as well as personal lives.

Another principle that the model supports is that there is a change over time in people's perspectives as they mature—from future application of knowledge to the immediacy of application. Thus, an adult is more problem-centered than subject-centered in learning. Moreover, adults need to know why they need to learn something before undertaking it. When learners understand the importance of professional development to their teaching and to their students and school in general, they may be more receptive and committed to participate. Finally, adults are motivated to learn by internal as opposed to external factors (Knowles, Holton III, & Swanson, 2005, pp. 64 & 68). As an individual matures, the motivation to learn is internal. Learners desire to develop and expand capabilities to attain their full potential. Learners want to use gained knowledge and skills, and they are performance-oriented in the learning process. According to Knowles (1980), adults are more responsive to learning when it is structured towards these six assumptions. From these assumptions, it is important to recognize that educational program planning should support the principles of adult learning.

Caffarella's (2002, p. 21) model consisting of 12 major components with tasks that need to be performed for each component is shown below.

Table 4. The Interactive Model of Program Planning

Discerning the Context	Be knowledgeable about the individuals, the organization and various factors that influence an education program i.e. power dynamics. Ensure all stakeholders have a place at the planning table and can freely express their ideas
Building a Solid Base of Support	Support key stakeholders such as teachers and educational administrators. Determine if continuous learning is valued at the institution.
Identifying Program Ideas	Consider a structured needs assessment and other sources such as teachers' feedback and suggestions as to create program ideas that are applicable to the learners.
Sorting and Prioritizing Program Ideas	Once needs assessment and ideas have been created, sort through and determine whether an educational program is an appropriate intervention to respond to the ideas and problems which have been identified or if it can be addressed using alternative approaches. This should include generating clear criteria for selecting one over another.
Developing Program Objectives	Write clear program objectives that reflect participant learning and changes that will derive from learning. Revise the objectives as the program progresses and is implemented. The objectives should be specific and measurable.
Designing Instruction Plans	Using the program objectives, organize the content to meet each of the objectives. Select appropriate instructional approaches that meet the learners' needs and learning preferences. (i.e. role play, lecture, hands on activity, etc.) and evaluation strategies that match the focus of the learning objective.
Devising Transfer-of-Learning Plans	Determine which skills need to be part of the transfer process and be exercised outside of the teaching and learning setting. Generate useful tools (i.e. checklist, tip sheets) learners can use to apply their new knowledge and skills.
Formulating Evaluation Plans	Specify the evaluation approach to use and the data collection methods to be used. Gather information about learners' satisfaction and knowledge gain.
Making Recommendations and Communicating Results	Examine program success and challenges. Prepare and share a detailed report in an appropriate format that the stakeholders who receive and read it will be able to easily understand.
Selecting Formats, Schedules, and Staff Needs	Determine the type of educational setting that will promote learning (i.e. online learning, informal group discussion, or lectures). Select the most appropriate and practical program format and schedule (i.e. selecting the best time of the day or week to have sessions that allows maximum participation) and identifying staff needs (i.e. external consultants).
Preparing Budgets and Marketing plans	Estimate the program expenses and how the program will be financed. Develop promotional materials and carry out an active promotional campaign.
Coordinating Facilities and On-site Events	Obtain suitable facilities including audiovisual equipment, refreshments, etc. and manage all of the on-site arrangements; create a positive environment for learning from the beginning of the program to the end.

Pedagogical Content Knowledge (PCK)

Most researchers would agree that teacher content knowledge is unavoidable in that understanding both content and pedagogy is critical to teacher success. Research in teaching draws its attention to knowledge base for teaching and had generated several findings that influence the reform of teacher education in light of understanding how teachers' knowledge informs their practice. Shulman (1986) proposed an emphasis on PCK at a time when content and pedagogy were considered unconnectedly, and pedagogy was overemphasized. Although teacher content knowledge is crucial to the improvement of teaching and learning, it was not ignored and received little attention. Shulman (1986) uncovered that developing teachers need to involve a knowledge base of pedagogy, construct a basis for content knowledge and achieve the added knowledge of many educational contexts. Shulman (1986) indicated that the negligence of understanding subject matter content in the various paradigms for the study of teaching as the "missing paradigm" (p. 7). The presence of subject matter is necessary in studying teaching.

Firstly, subject matter content knowledge is the amount and organization of knowledge in the mind of the teacher (Shulman, 1986). Teachers should have the ability to transfigure their subject matter knowledge to be conveyed to students in a simple manner that could be easily acquired by students. Secondly, pedagogical content knowledge is "the way of presenting and formulating the subject matter that makes it comprehensible to others" in subject areas that teacher teach frequently (Shulman, 1986, p. 9). The concept of PCK also maintains an understanding of what makes the learning of particular topics more or less challenging for students of different ages, and background to understand. As Shulman (1986) indicated "the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning should be of those frequently taught topics and lessons (p. 10). In the case that the preconceptions are misconceptions, in which according to Shulman they usually are, teachers need knowledge of the strategies to be effective in reorganizing the understanding of students because those students are not empty vessels waiting to be filled with knowledge. Teachers need to understand the preconceptions and background that students bring to the classroom and be informed of approaches and instructional materials that can be relevant.

Thirdly, if teachers are often negligent in not teaching pedagogical knowledge to students, they are even more negligent with regard to the third category of content knowledge which is curricular knowledge. The curriculum is characterized by a variety of programs designed for teaching of specific subjects and topics at a certain level and a range of instructional materials available in connection with such programs. These types of professional knowledge are crucial to teachers in order to give their students the opportunity for a meaningful learning experience.

The 21st century skills elevated the standards to transform in education; subject matter, pedagogical skills, assessment, the ICT are all essentials to support students (Nuangchalerm, 2012). Teachers must be imparted with the skills and knowledge to develop a pedagogical content knowledge so that they can critique and challenge traditional pedagogy (Nuangchalerm, 2009). Pedagogical content knowledge involves combining content and pedagogy into an understanding of how various issues, and problems and topics are prepared, represented and tailored to the varied interests and ability of students and impart for instruction (Nuangchalerm, 2011). Pedagogical content knowledge allows the teacher to know which instructional approaches are suitable with the content and how components of the content can be organized for effective science teaching (Nuangchalerm, 2011). Hence, teacher should know how to teach their students by concentrating on the subject matter, content, and integrate pedagogy to have a successful classroom (Nuangchalerm, 2012).

Similarly, teacher professional development programs should be reconsidered to ensure that teachers' qualities are in accordance with the ever changing world (Nuangchalerm, 2012). Teachers' subject knowledge and pedagogy need to be applied in the teacher professional development programs in schools (Nuangchalerm, 2009). Teacher professional development programs need to promote pedagogical content knowledge and teaching strategies for teachers because it is not only vital for classroom, but also it assists teachers' qualities to be highly professional (Nuangchalerm, 2012). It is imperative to incorporate pedagogical content knowledge in teacher professional development programs because teachers' content knowledge or pedagogical knowledge alone does not have much impact to their professional development. These two knowledge bases should be combined in order to effectively develop and transform teachers (Nuangchalerm, 2012). Thus, the aspect of subject matter knowledge and pedagogical knowledge can help teachers have positive attitudes in teaching science (Nuangchalerm, 2012). Importantly, pedagogical content knowledge will be improved if teachers understand nature of teaching science, innovative lesson design, inquiry-based learning, and 21st century skills (Nuangchalerm, 2012). Therefore, professional development that addresses PCK and curricular knowledge is vital to attaining effective teachers and high quality instructional practices for students (Nuangchalerm, 2012).

Table 5. Shulman's forms of teaching knowledge

Form of Teacher Knowledge	Description
Subject Matter Content Knowledge	▪ Amount of knowledge ▪ Organization of knowledge
Pedagogical Content Knowledge	▪ Knowledge of subject matter for teaching ▪ "The way of presenting and formulating the subject matter that makes it comprehensible to others" (p. 9) ▪ An understanding of what makes the learning of specific topics easy or difficult: conceptions and preconceptions about the subject area ▪ Strategies to address some aspect of subject areas conceptions and preconceptions
Curricular Knowledge	▪ Knowledge of various programs and instructional materials to be used for specific subjects and topics such as visual materials, software, laboratory demonstrations, invitations to enquiry etc.

Inquiry-based Approach

The National Science Education Standards have been one of the leading reformed documents in the U.S. since its release (Campell & Smith, 2013). The NSES (1996) present guidelines for the science education in primary and secondary education in the US. The teaching standards are promoting inquiry as "central strategy for teaching science" (Keys & Bryan, 2000). Through participating in professional development events, Tanzanian secondary school science teachers may learn research-proven instructional strategies, such as the inquiry-based approach. As Stigler and Hiebert (1999) asserted, "teachers are only as good as the methods of teaching they use" (p. 175). In this case, inquiry is regarded as an effective approach to the learning of science and reflects how science teaching is performed. According to the National Research Council (1996), inquiry is defined as:

> A multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental

> evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations. (p. 23)

The primary focus is on inquiry-based learning with less stress on factual-based learning and more emphasis on how science itself is carried out. The National Science Education Standards also bring about a change in the manner in which students are taught and how they must think in order to gain scientific knowledge, skills, and abilities. The central aspect of the National Science Education Standards (1996) is inquiry-based learning, whereby students are given the opportunity to reason and think logically to put their scientific knowledge to use.

History of Inquiry-based Teaching

Prior to the twentieth century, most educators regarded science predominantly as a body of knowledge that students must learn through direct instruction (NRC, 2000). However, John Dewey, a former science teacher, opposed this perspective. The notion of inquiry-based teaching and learning stemmed from Dewey's philosophy that advocated for student-centered pedagogy and inquiry-based education. Dewey (1916) thought that the primary function of education was to improve the reasoning (cognitive) process. Thus, Dewey (1910) proposed the incorporation of inquiry into the K-12 science curriculum. Dewey's criticism of direct instruction was that it focused too greatly on facts, resulting in insufficient emphasis on critical thinking. Dewey stated that the problems studied in school should be generated from everyday interests, needs and, critically, the experiences of the students (Dewey, 1902).

According to Dewey (1902), learning must have personal meaning to the student, because her/his world is a world with personal interests rather than a realm of laws and facts. Dewey believed that thinking occurs when an individual tackles a given problem and that every learner needs to make use of knowledge in order for it to be meaningful and retained. Moreover, Dewey claimed that learning takes place when the mind actively engages in an effort to find applicable solutions to problems by drawing on prior knowledge and experiences, creating a strategy to solve problems, and, lastly, evaluating the effects of action (Dewey, 1902). Teaching science through inquiry emphasizes the students doing the learning and constructing their own knowledge. This reinforces what Dewey highlighted: Learning occurs through action and becoming actively involved in an experience. Campell and Smith (2013) corresponded with Dewey stating that scientific inquiry is the teaching method put forth as aligned with constructivism in science education.

The Inquiry-based Classroom

A rising number of business leaders, politicians, and educators discuss the notion that students need "21st century skills" to be successful in the present day (Rotherham & Willingham, 2009). The necessity of the 21st century requires education to continue developing the young generation who have life skills so that they can survive and be competitive in the global community (Andrini, 2016). These skills include: the ability to think critically, the ability to communicate effectively and efficiently, the ability to solve problems etc.

The 21st skills favor student-centered methods in which students are allowed to collaborate, work on authentic problems and engage in the community (Rotherham & Willingham, 2009). A teaching and learning method such as inquiry can train students to express opinions and construct their own knowledge that is beneficial in solving problems (Andrini, 2016). In inquiry learning, students have the opportunity to connect new information with prior knowledge resulting in meaningful learning. When inquiry learning method is used efficiently and effectively, it will reduce the domination of teachers in mastering the course of the learning process, and the boredom in of the students in the classroom will be diminished (Andrini, 2016).

The teacher cannot perform inquiry for students; in order to be involved in inquiry learning, students must do the inquiring (Aulls & Shore, 2008). The instruction must be more focused on the learner than on the teacher to support inquiry learning. In inquiry, students become active learners and take more responsibility for their own learning (Aulls & Shore, 2008). In an inquiry-based classroom, inquiry should be part of the classroom's central goal and be practiced regularly rather than exercised occasionally (Aulls & Shore, 2008). In terms of the quality of student learning, a student-centered approach is a better type of instruction than a teacher-centered approach (Aulls & Shore, 2008).

The continuous interaction between humans and the physical environment enhances a person's abilities to construct knowledge. A key theme of the constructivist theory is that learning is an active process in which learners construct new concepts and ideas that are based upon their past or current knowledge (Chi, 2009). Dewey suggested that students be taught so that they are able to expand their personal knowledge of science. This means that teaching is to be directed at students' needs, interests, and everyday experiences. Students should be actively engaged in activities which promote their ideas and problem-solving skills, while the teacher takes on the role of guide and facilitator, thus promoting a student-centered classroom (Dewey, 1916).

Science teachers are expected to understand and be able to teach science using an inquiry-based approach (NRC, 1996, 2000). However, there are many understandings and interpretations of what signifies inquiry-oriented teaching, ranging from engaging students in hands-on activities to asking many questions (Llewellyn, 2013). Some clarifications are derived from descriptions of classroom inquiry presented and stated by the National Research Council (NRC, 1996, 2000) which helps to elucidate what "inquiry instruction" constitutes. Highlighted in these documents is the idea that it is imperative that K-12 science teachers know that inquiry entails the following: the cognitive abilities that students must develop; an understanding of methods used by scientists to search for answers to students' research questions and the diverse teaching strategies that aid students in learning about scientific inquiry; developing student inquiry abilities; and further the understanding of scientific concepts (NRC, 1996, 2000).

Carrying out inquiry entails more than just employing science-processing skills in the classroom—it also acknowledges that not all science concepts can be or should be taught using inquiry (NRC, 1996, 2000). The standards require high school teachers to plan activities that engage students in the blending process and develop critical reasoning skills to develop deeper understandings of science (Llewellyn, 2013). According to the standards (NRC, 1996), engaging high school students in inquiry helps to develop: (1) an understanding of scientific concepts; (2) an appreciation of "how we know" what we know in science; (3) an understanding of the nature of science; (4) the skills necessary for becoming independent inquirers about the natural world; and (5) the dispositions to use the skills, abilities, and attitudes associated with science (Llewellyn, 2013, p. 3).

Thus, following the standards above, students are ideally able to understand specific formulas, how they relate to phenomena, and how to have an understanding of scientific facts outside of a textbook. Students should develop an understanding in terms of questioning and experimentation as well as theory and law connected with repeated successful experiments that can be called facts. These facts and theories are then disseminated among the scientific community. Students should come to recognize that the nature of science is questioning the world and phenomena around us and, then, empirically testing hypotheses to make sense of them. Students will grow to be independent researchers by repeated testing and experimentation associated with intellectual questioning and by drawing from multiple scientific concepts, thus leading to a further understanding of these concepts. This may require mentorship and repeated trial and error before a student becomes independent enough to work on his or her own. Eventually, students should develop attitudes and approaches that allow them to analytically critique other experiments and learn how to solve real-world problems that require scientific application.

Standards of Inquiry

The emphasis of the standards of inquiry is on the ability to carry out inquiry and develop an understanding of scientific inquiry:

> Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments (NRC, 1996, p. 105).

The principles stated above are aimed at encouraging students to use such an approach in developing their curiosities in a wide range of scientific dimensions and to think critically when designing experiments or investigations. Students are given as many opportunities as possible to think and use their minds when conducting scientific practices. Students find ways of organizing a task to be performed, which means they interact with each another regarding a problem and find better ways of arriving at conclusions with regard to analysis, observations, and interpretations that are soundly supported by the general findings. Another purpose for the standards of inquiry is to help students develop strong scientific arguments and therefore to be able to present them to a broad range of audiences, e.g., their classroom peers.

Levels of Inquiry

Banchi and Bell (2008) described four types of science inquiry activities that differ according to students' independence levels. These levels include confirmation, structured, guided, and open-ended inquiry; all of these levels should build upon each other. Confirmation inquiry is the most basic type of inquiry, where students learn a concept by being provided with questions, procedures, and answers. In other words, in this inquiry level, students are provided with a problem, procedures, and a solution that is known in advance. Basically, they explore a question given by the teacher through procedures that the teacher determines, and they obtain detailed step-by-step guidelines for each stage of the investigation to confirm the known principle. Structured inquiry is also a teacher-directed inquiry. The teacher presents the question and procedures to students and lets the students analyze the data and formulate their own conclusions. Students follow the teacher's instructions in carrying out a scientific investigation to discover a result that is not known by students (Banchi & Bell, 2008).

In guided inquiry, the teacher helps students by offering a set of questions from which students choose and allows them to come up with the procedures to analyze and discuss their own data and draw conclusions to a prescribed problem. By this stage, students are about to completely take on the role of self-learning; by asking a question, students are able to learn the content being taught most effectively through their own procedures and data collection. The last and highest level of inquiry is open-ended inquiry. It is a student-directed level in which the teacher provides a topic and allows students to formulate their own questions, procedures, and data which they will then discuss and present to their peers at the end of the investigation (Banchi & Bell, 2008). Generally, on this level, students take the lead in the investigation and begin the inquiry process by creating scientific questions, making their own decisions about the design and the process of carrying out the inquiry, and sharing their results.

According to Banchi and Bell (2008), many teachers strive and have a desire for their students to be able to reach open-ended inquiry; however, teachers should not set this to be their only goal. Open-ended inquiry, while effective, can be difficult for all students in a classroom to achieve. For this reason, teachers must utilize the different levels of inquiry as a part of their teaching strategies.

Therefore, adapting to constructivist ways of teaching can lead Tanzanian secondary school science teachers to develop teaching approaches that can help students make explicit the connections between new knowledge and prior learned knowledge; this can be the most effective way of learning as it helps students develop new ideas and deepen their understandings of the concepts. Such approaches engage and motivate students with interesting socially and culturally applicable activities and experiences that give them opportunities to uncover, understand, reflect upon and apply the learned concepts. In addition, these strategies allow students to engage in meaningful dialogue with peers as well as teachers regarding the content. Similarly, a constructivist approach engenders regarding the teacher as a guide or facilitator of learning, rather than merely being a transmitter of facts or information.

Teachers need to adapt to change and learn how to use the inquiry-based approach. “Learning is about change, and adult learning is also about change” (Cercone, 2008, p. 142). It has been emphasized that science teacher preparation programs must provide inquiry training for both their teacher education and science courses; otherwise, there will not be a major impact on enacting inquiry in K-12 classrooms (Barrow, 2006). Orientation and training must be delivered to teachers at both the pre-service and in-service levels (Barrow, 2006).

In support of Renyi's (1996) characteristics of professional development (those that reinforce the 21st century skills presented on Table 1), the National Science Education Standards (NRC, 1996) provided a vision of teaching and learning science that would allow all students to become scientifically literate. Generally, the idea is that teachers of science are professionals accountable for their own professional growth and for keeping up with their teaching profession. The standards present criteria for assessing the quality of the professional development opportunities that science teachers need to engage in to effectively implement the National Science Education Standards. In the professional development, science teachers are to learn essential science content through perspectives and the inquiry approach (NRC, 1996).

Professional development standard A in the National Science Education Standards (NRC, 1996) states that teachers' experiences of learning must consist of the following attributes:

> (1) Involve teachers in actively investigating phenomena that can be studied scientifically, interpreting results and making sense of findings consistent with currently accepted scientific understanding; (2) Address issues, events, problems, or topics of significance in science and of interest to participants; (3) Introduce teachers to scientific literature, media, and technological resources that expand their science knowledge and their ability to access further knowledge; (4) Build on the teacher's current science understanding, ability, and attitudes; (5) Incorporate ongoing reflection on the process and outcomes of understanding science through inquiry; (6) Encourage and support teachers in efforts to collaborate (p. 59).

Benefits of Inquiry-based Teaching and Learning to the Student

There are several benefits of implementing an inquiry-based approach that could inspire learners. Foremost, Schwab (1960) deemed that science should be taught in a manner consistent with the way in which modern science works; he suggested that science be taught using an inquiry format. Traditional approaches focus on content; however, the inquiry-based method focuses on the learning process. Students consequently acquire a knowledge base in the subject matter. As Bybee (1997) maintained, science teachers should not separate science content from the process of science; instead, they should combine science processes with scientific knowledge, reasoning, and critical thinking so students are able to develop a richer, more profound understanding of science. Inquiry learning can substantially improve student achievement and knowledge acquisition compared to traditional learning. (Saunders-Stewart, Gyles, & Shore, 2012).

The National Science Education Standards proposed that "engaging students in inquiry helps students develop an appreciation of how we know what we know in science" (National Research Council, 1996, p. 115). In inquiry-based learning, students understand science concepts rather than just memorizing facts. Inquiry involves a self-guided investigation of a meaningful topic, thus students develop the ability to pursue a topic of interest in-depth, which results in a deeper understanding (Saunders-Stewart et al., 2012). In addition, students are more engaged in the construction of knowledge through active involvement, and they can apply the knowledge or skills they developed during learning to new contexts (Saunders-Stewart et al., 2012). This means students have the ability to relate their learning to other concepts beyond the ideas they were taught and make connections with them. Being able to see concepts as related is pertinent to the ability of students to apply knowledge or skills in different situations. For instance, when students who have learned and mastered a pollution lesson in the classroom understand that they can play an important role in reducing pollution and increasing recycling rates in order to have a healthier environment, they can transfer their knowledge by applying what they learned in the classroom to their homes; this is the purpose of inquiry. Inquiry learning is grounded in the social constructivist theory and epistemologically asserts that minds are not blank slates; rather, students enter learning environments with their unique experiences, knowledge, and understanding (Vygotsky, 1978).

Similarly, a research study conducted by Bransford, Brown, and Cocking (1999) indicated that students develop a deeper understanding of science concepts when prior knowledge is considered as they incorporate new knowledge. Generally, learning is improved when teachers consider the knowledge and beliefs that students bring to a learning task and utilize this knowledge as a basis for new instruction and to observe the changing viewpoints of students as learning and instruction progress. Learning is a process of integrating and adapting prior understanding to include new information. It is a student process in a social context (Saunders-Stewart et al., 2012).

Inquiry learning enables critical thinking and problem-solving skills which are needed for creating life-long learners (Saunders-Stewart et al., 2012). Likewise, the National Research Council (2000) affirmed that when students practice inquiry, it aids them in developing their critical thinking abilities as well as scientific reasoning whilst acquiring a deeper understanding of science. Furthermore, students learn how to learn—this is lifelong learning (Saunders-Stewart et al., 2012). Students become independent learners and interest-driven, develop curiosities, and become lifelong-learners (Aulls & Shore, 2008). Inquiry learning focuses on problem-solving processes; students formulate hypotheses, gather relevant resources, data, and evidence, draw conclusions through their own interpretations and communicate their findings to their teacher and peers. These skills allow students to seek questions of interest and discovery throughout their lives (Saunders-Stewart et al., 2012).

In an inquiry-oriented classroom, students have discussions with peers. They share and present conclusions in a cooperative learning environment, and as a result, students develop positive attitudes toward the subject and learning in general. In contrast, in traditional instruction students listen to lectures, use textbooks and are offered occasional demonstrations (Saunders-Stewart et al., 2012). Additionally, students are able to build self-confidence and self-efficacy and develop heightened self-esteem, because they work independently and experience aspects of empowerment in a learning setting (Saunders-Stewart et al., 2012).

Unlike in a traditional classroom, where simplistic problems are carried out, in an inquiry-oriented classroom activities performed are based on complex, real-world problems in which there are many solutions and paths. These activities intend to develop task commitment and motivation by conducting self-directed investigations. Thus, students are motivated as they tackle problems which are intrinsically interesting to them with an appropriate level of challenge to foster an environment for task commitment (Saunders-Stewart et al., 2012).

Since students conduct self-directed investigations, they are able to develop expertise by engaging in inquiry (Saunders-Stewart et al., 2012). Students work collaboratively in groups, share ideas, and utilize the expertise of one another instead of depending on the teacher to take the role of expert. Students' ideas, viewpoints, and efforts are valued and shared as those of practicing professionals (Saunders-Stewart et al., 2012).

Inquiry-based learning promotes student ownership. The relationship between the teacher and students shifts. More precisely, there are diversifications of the roles undertaken by the teacher and students. Instead of all of the instruction and evaluations emanating from the teacher, every student in the classroom is given an opportunity to share in these responsibilities (Aulls & Shore, 2008). Students are even capable of adopting and carrying out the roles that are typically perceived as belonging to the teacher. In this case, a teacher's role can include facilitating dialogue, and students' roles may include decision-making, exploring, reflecting, and interpretation.

To conclude, in a traditional classroom, a teacher asks a question, and the students respond to it. When students make errors, the teacher corrects them on the spot. A teacher solves exercises on the board, and students copy them. However, inquiry-based teaching gives the students opportunities to share their understanding with each other and take responsibility for their own learning (Khan, 2012). Vygotsky (1962) asserted:

> Direct teaching of concepts is not possible and would not be successful. A teacher who tries to do this usually accomplishes nothing but empty verbalism, a parrotlike repetition of words by the child, simulating a knowledge of the corresponding concepts but actually covering up a vacuum. (p. 83)

In an inquiry-based classroom, students learn how to learn; the teacher is supporting students' pursuit for knowledge and their curiosity about science. In a traditional classroom, students listen and reiterate the expected answers and memorize facts—skills that do not serve the needs of modern society. Inquiry-based learning, on the other hand, requires individuals to possess problem-solving and critical thinking skills. In an inquiry-based classroom, students do not seek an answer from their teachers; instead, they are actively involved in designing investigations, collecting and analyzing information, and synthesizing and drawing conclusions. This teaching and learning approach enables students to develop useful critical thinking and solving skills, which can be applied to future situations, questions or issues that students may encounter both in a school setting as well as in the workplace. Therefore, Tanzanian science classrooms need to shift from a teacher-centered to a student-centered environment because a teaching method such as lecture simply transmits information to students. As Gallet (1998) declared,

> The transfer of information is relegated to a simple accumulation of knowledge through lecturing. As soon as one wants to go beyond the stage of raw knowledge, however, lecturing does not suffice any more. It does not develop the students' critical sense or judgement, nor does it permit them to think for themselves when placed in an unknown terrain (p. 72).

Science teachers should not depend entirely on lectures, as a traditional teaching technique, it can students passive in the classroom and allowing very little time for students to process the new information or concepts learned. Instead, they should strive on becoming inquiry-based teachers so that they can allow students to actively participate in learning process to develop their own understanding of scientific knowledge.

Undoubtedly, inquiry-based instruction may present new and different classroom circumstances for teachers and students, but both will need to progressively make a transition to inquiry-based teaching until they feel comfortable. The key is for teachers to transform from being the source of knowledge to being facilitators of learning and allow students to be more independent and responsible for their learning processes.

Barriers for Implementing the Inquiry-based Approach

Student success in inquiry learning environment depends on skilled and thoughtful guidance from teachers. However, teachers face substance dilemma in teaching science as inquiry (Harris and Rooks, 2010). Barriers that teachers encounter in implementing inquiry have been discussed in the literature for a long period of time (Anderson, 2002). The words “barrier” and “obstacles” signify external factors to a teacher; however, the word “dilemmas” implies factors intrinsic to a teacher (Anderson, 2002). Much of the difficulty that teachers encounter is carried internally, and this includes beliefs and values related to students, teaching, and the purpose of education (Anderson, 2002). Studies provide a model of these barriers and dilemmas in implementing inquiry instruction. Anderson (1996) outlined and presented these barriers and dilemmas in three dimensions: the technical, the political, and the cultural.

In support of these three dimensions of dilemmas teachers face, Johnson (2006) conducted a study that applied Anderson’s (1996) framework for examining the dilemmas and barriers teachers encounter in implementing reform-based instruction. The study was directed at middle school teachers. They engaged in collaborative, sustained, whole-school professional development in implementing inquiry to meet the National Science Education Standards or standards-based instructional practices (Johnson, 2006). The results revealed that even with effective professional development, science teachers still faced the same dilemmas: technical, political, and cultural difficulties to implementing inquiry methods.

The Technical Dimension

Examples of the technical dimension include limited ability to teach constructively, the challenges of assessment, difficulties of group work, challenges of new teachers' roles, challenges of new students' roles, and inadequate in-service education. Anderson (1996) indicated that teachers may be committed to teach for understanding and the development of critical thinking; however, they may lack a full understanding of how to actually do this. They may not be able to organize and conduct their instruction in ways that would yield the desired results. In addition, teachers carry on with their prior commitments to particular instructional practices that hinder them from using new forms of instruction. An example of this barrier would be teachers who use textbooks as a primary method of instruction. These teachers' deep-rooted belief is that it was imperative for students to learn largely by using textbooks (Anderson, 1996).

Students' tasks, such as recording information from teachers, following detailed teacher directions, and memorizing information, require new skills and knowledge on the role of the teacher (Anderson, 1996). These skills include interpreting and explaining information and designing their own activities with less dependency on the teacher. This student-directed effort translates to problem-solving, reasoning, and reading and writing for meaning (Anderson, 1996). Generally, technical barriers consist of teachers' content knowledge, pedagogical knowledge, and the ability to apply the knowledge to inquiry instruction. In Johnson's (1996) study, technical barriers include a lack of instructional and content skills that are required for teachers to effectively implement standards-based instruction. Other technical barriers include time for planning, class management issues, instruction and collaboration, and inadequate in-service education.

The Political Dimension

The political dimension involves limited professional development opportunities, e.g., unresolved conflicts among teachers, parental resistance, lack of resources and differing judgments about justice and fairness (Anderson, 1996). In terms of unresolved conflict, Anderson (1996) reminded us that the occurrence of conflict is not an issue, but the challenge comes when individuals do not know what steps to take in order to resolve the issues. According to Johnson (2006), a lack of resources, the local leadership and support, a lack of schoolwide collaboration, and insufficient professional development opportunities were shown to be barriers in the political dimension. Clearly, studies conducted in schools revealed that there are political obstacles that hinder teachers from meeting their instructional principles. For instance, McLaughlin and Talbert (2006) pointed out that major political obstacles in schools include the shortage of professional development opportunities, the absence of support from administrators, and hardships teachers encounter resulting from a lack of time and resources.

The Cultural Dimension

The cultural dimension examines teachers’ internal dilemmas, such as beliefs and values regarding their instruction. This dimension is the most critical, because fundamental beliefs and values are at the heart of teachers’ commitment to a traditional viewpoint about educational practices (Anderson, 1996). This is where the traditional way of teaching, using textbooks as the primary teaching method, comes in. Beside teachers’ beliefs and values regarding teaching, cultural barriers also focus on the alignment of assessment, instructional practices and perceptions regarding teachers’ collaboration within the school (Johnson, 2006).

Anderson (1996) emphasized that educators responsible for providing professional development often focus on the technical dimension and not on fully presenting the cultural dimension, in this case, teachers' values and beliefs. Thus, Anderson (1996) recommended that both the technical and cultural dimensions must be attended to in the provision of professional development opportunities. Importantly, the process of a teacher's transformation from a traditional to a reformed educational model should not be expected to occur or be resolved quickly. These efforts to effect change should be expected to result in considerable tensions for teachers as they struggle with their deep-rooted values and beliefs (Anderson, 1996).

In summary, Anderson (1996) pinpointed three dimensions of dilemmas and barriers teachers encountered when implementing reform work: technical, political and cultural. All of these dimensions are important; thus, the obligation to prepare and train teachers for inquiry should not only focus on technical issues, but all three dimensions should be combined. The issues must be addressed systematically and in depth in the technical, political and cultural context of the schools in which teachers' efforts are carried out (Anderson, 2002).

Inquiry Related Professional Development Studies

There are numerous studies that focus on various forms of professional development. Several of them highlighted that science teachers need to participate in professional development programs to learn different instructional strategies, including inquiry, before they are expected to implement those new or improved strategies (Kazempour, 2009; Loucks-Horsey et al., 2003; Mumba et al., 2015; Supovitz & Turner, 2000). Some of those studies have examined the outcome of the professional development activities to test whether teachers who have attended professional development events implement into their classrooms what they learned. These studies emphasized that professional development programs should be intensive and long-term, allowing teachers to collaborate with their peers, focus on the content knowledge, and have time for reflection.

Various schools have implemented inquiry teaching method programs for secondary school teachers in order to improve the quality of science teaching in their classrooms. These studies have discovered that science teachers who participated in professional development activities were more likely to change their instructional practices. The first program is called the "Master of Arts in Teaching program," where pre-service biology teachers were enrolled for a year to learn different techniques to teach science with the key focus being inquiry instruction (Binns & Popp, 2013). The second program is the "Physics by Inquiry Program" in which teachers were taught teaching strategies by engaging in inquiry science activities and expanding their understanding of the science concepts that they usually teach (McBride & Bhatti, 2004). "As the teachers understand the process of science as inquiry, the teachers more eagerly teach the process to their students in the same way as they learned in the Physics by Inquiry program" (McBride & Bhatti, 2004, p. 434). In this program, teachers also attended inquiry workshops held in a physics laboratory, and the teacher educator led the workshops. The workshop was aimed at extending teachers' understanding of the science content taught through inquiry-based science activities and by helping the teachers to develop the skills necessary to interact with their students (McBride & Bhatti, 2004).

There are other workshops where teachers learn to foster understanding and belief in inquiry-based learning so that they can overcome obstacles in transforming from a "cookbook" lab (a method in which the students are told exactly what to do and how to do it) to inquiry-based labs (Bohrer, Ferrie, Johnson, & Miller, 2008). All the above-mentioned programs provide strategies and techniques to assist teachers in implementing inquiry in their classrooms. These workshops, which also serve as professional development for teachers, employ activities that relate to standards and curricula that illustrate aspects of inquiry.

Marshall and Smart (2013) conducted a study to examine secondary school teachers responses to a professional development program intended to assist in the transformation of inquiry instructional practices. The results of this study revealed that all teachers came became aware of inquiry-based instruction; all increased their understanding; all transferred new knowledge regarding inquiry instruction into practice; all practiced these new strategy; all reflected on emerging pedagogy.

Some studies indicated that most teachers lack a whole understanding of inquiry. For that reason, inquiry-based instruction has been problematic for some teachers to accept and implement in their classrooms (Mumba, Banda, Chabalengula, & Dolenc, 2015). Unfortunately, most preservice teachers rarely experience inquiry-based instruction in their undergraduate science courses (Roehrig, Michlin, Schmitt, MacNabb, & Dubinsky, 2012). Professional development is a strategy for improving teaching (Kazempour, 2009). Professional development can be a tool for teachers to be cognizant of their learning and can provide a learning experience in which they are able to evaluate and enhance their own skills, knowledge, and teaching approaches (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). High-quality professional development will yield superior teaching in classrooms as a result and will lead to higher levels of student achievement (Supovitz & Turner, 2000). Participating in professional development may allow teachers to recognize their own learning and integrate it into their science teaching. Yet, a study conducted by Desimone et al. (2002) discovered that teachers who participated in professional development that concentrated on particular teaching practices increased the use of such practices in their classrooms. Therefore, one of the efforts required in ensuring all students gain the 21st century skills is that schools need to renovate how they think about human capital in education, specifically how teachers are trained (Rotherham & Willingham, 2009).

Steps Needed for Becoming an Inquiry-based Teacher

Llewellyn (2013) proposed five essential steps that can help teachers to become inquiry-based teachers. Each stride, in essence, plays a substantial role in developing the capacity to teach through inquiry and progresses from “ordinary to extraordinary” (Llewellyn, 2013). The five essential steps include the following:

First, build an understanding of inquiry. Teachers become cognizant that science is grounded in questions. Also, science is empirical, which means it is experimental and based on observations and inferences. Therefore, comprehending the nature of science (NOS) is a significant part of developing into an inquiry teacher (Llewellyn, 2013). It is equally imperative to distinguish between the “scientific method” and scientific inquiry given that science does not always progress in a linear, step-by-step manner (Llewellyn, 2013).

Second, develop an understanding of the change process. The acknowledgement of the process of change and transformation in classroom practices may take 3 to 5 years, and that systemic change comprises the following: reorganization of the science curriculum and lessons, including an amendment to traditional labs; replacement of the teacher’s instructional methods and questioning skills through on-going professional development; and alteration of the classroom and relationships to promote inquiry-based approaches and learner-centered environments (Llewellyn, 2013). Instructional change also entails setting professional goals and expectations by recognizing the present and desired states, performing individual self-assessment and planning for appropriate professional development to enhance teachers’ performance by means of practice and reflection (Llewellyn, 2013).

Third, construct a mind-set for the emerging pedagogy. This is one of the more significant steps to becoming an inquiry teacher. As teachers change from a transactional to a transformational approach of instruction, they come to understand that simply transmitting knowledge to students does not prepare or develop students into independent learners who are capable of investigating and synthesizing new knowledge on their own. In this step, teachers move toward a constructivist philosophy of teaching and learning, which suggests and emphasizes inquiry and critical thinking, in the sense that students are given opportunities to negotiate meaning through exploration and discussion (Llewellyn, 2013). Teachers come to understand that knowledge is constructed, not imparted, transmitted or absorbed (Llewellyn, 2013, p. 61).

Fourth, translate new knowledge into practice. Teachers will learn how to change traditional, time-honored labs into more inquiry-oriented opportunities. Transferring new knowledge into practice also means improving teachers' questioning skills. Inquiry is more about seeking the right questions than about finding the right answers (Llewellyn, 2013).

Fifth, teachers need to create a culture of inquiry. This step requires a systemic reorganization, which suggests encouraging relationships and building trust between teachers and students as well as between students and their peers. In addition, teachers should promote and support creativity by allowing students to take risks; present students with increasing accountability for determining how to design their investigations; suggest possible solutions; gather and organize evidence to support or disprove their propositions; and construct meaning of their results by generating and communicating explanations through scientific argumentation (Llewellyn, 2013).

The Concern-Based Adoption Model (CBAM)

In education, change is endless. Teachers constantly implement newly adopted innovations to assist their students, transform their practices, and develop themselves. Resistance to change is inevitable when faced with innovation. Thus, teachers may display indications of resistance perhaps because a new approach of teaching and learning is imposed on them. Generally, in attempts to change, individuals will appear to resist the change and others may even disrupt efforts for change (Hall & Hord, 2006).

The success of change efforts varies depending on the way individuals interpret and perceive the innovation. The success of change initiatives depends on educators accepting change, and when moving onto any reform effort, school leaders and change agents should take into account the chance of encountering resistance (Zimmerman, 2006). Naturally, individuals do not all perceive the world or their places of work in the same way (Zimmerman, 2006). Individual teachers may experience change differently, and the manner in which individuals perceive innovation may influence the effectiveness.

In order to understand facilitating change, the Concern-Based Adoption Model (CBAM) was designed to assess concerns expressed in the adoption of innovations. The CBAM was developed in 1973 at the Research and Development Center for Teacher Education. The model focusses on measuring, describing, and explaining the process of change experienced by teachers involved in attempts to implement new curriculum materials and instructional practices (Anderson, 1997). At times, teachers undertake classroom-oriented changes as a result of curriculum and professional development activities, and sometimes, they are positioned in situations in which they are expected to implement new policies, instructional practices, and curriculum that have been instructed by their school system or school authorities without communicating the request or consent of the teachers themselves (Anderson, 1997).

According to Anderson (1997), there are many assumptions regarding classroom change in curriculum and instruction support CBAM: (1) change is a process, not a one-time event; (2) change is performed by individuals; (3) change is a deeply personal experience; (4) change involves developmental growth in feelings and skills; and (5) change can be facilitated by interventions targeted toward the individual, innovations, and context involved.

The process of change can be more successful if researchers and educators utilize the three diagnostic instruments of CBAM to consider the concerns of individuals who are involved in a process of implementing innovative i.e. teaching strategies or curriculum reform (Hall & Hord, 1987). According to Hall and Hord, (2006), three dimensions have been identified through research for conceptualizing and measuring change in individuals. These are: Stages of Concern (SoC), Level of Use (LoU), and Innovation Configuration (IC). With regard to these three sets of diagnostic information, the change facilitator is sufficiently knowledgeable in providing interventions, meaning, and actions that affect and facilitate teachers' use of new programs or practices.

Stages of Concern: Stages of Concern is a framework that describes the feelings and motivations a teacher might have regarding a change in curriculum and/or instructional practices at different phases in its implementation. In Stage 0, Awareness, the teacher has little knowledge about or interest in the change. The teacher is interested in learning more about the innovation and the implications of its applications in Stage 1, Informational. Stage 2, Personal, reveals strong anxieties regarding the teacher's ability to implement the change, the relevance of the change, and the personal costs of getting involved. In Stage 3, Management, the teacher starts to experiment with implementations; teacher concerns deepen in the logistics and new behaviors are connected in terms of placing the change into practice. The teacher's focus rests primarily on the impact of the change on students in their classrooms in Stage 4, Consequence; it also concentrates on the possibilities of modifying the innovation or their use of it to enhance its effect. Stage 5, Collaboration, reflects the teacher's interest in working with others in the school to jointly improve the benefits of change implementations for students. In Stage 6, Refocusing, the teacher is thinking about making major changes in the use of the innovation or possibly replacing it with other alternatives (Anderson, 1997).

While SoC focus on individuals' feelings, perceptions, reactions, and attitudes towards the change efforts, the CBAM LoU framework focuses on general patterns of teacher behavior as they prepare to use, begin to use, and gain experience implementing a classroom change (Anderson, 1997). Basically, LoU focuses on the behaviors of teachers experiencing a change initiative and describes how these teachers act toward the innovation. LoU offers another way to observe where teachers are positioned on the implementation path, and this contributes to recognizing the progress in implementing the change initiative.

With regard to LoU, it is possible to predict which is likely to occur further along the way as the change initiative continues to unfold. Generally, before assessing the effectiveness of a new initiative, program developers/education leaders need to consider the actual changes in practice i.e. the level and commitment in which the teachers are implementing the program or a new innovation. The LoU enables educators to determine the extent to which teachers are implementing the changes i.e. curriculum reform or instructional methods etc. and their level of expertise with it. The LoU comprise of eight behavioral profiles that describe the actions that teachers engage in as they become more acquainted with and competent in using teaching practices or adopting changes

It is important to note that although these approaches are presented in a hierarchical manner, they do not always occur in a set order (Anderson, 1997). These LoU categories are: 1. Non-use: The user has no interest. 2. Orientation: The user shows initiative to learn more about an innovation. 3. Preparation: The user has definite plans to use the innovation. 4. Mechanical: The user changes to better organize an innovation. 5. Routine: The user has established a pattern of use. 6. Refinement: The user makes changes to increase outcomes. 7. Integration: The user makes deliberate efforts to coordinate with others. 8. Renewal: The user seeks more effective alternatives to the established use of the innovation (Anderson, 1997; Hall & Hord, 1987, 2001).

The Concern-Based Adoption Model (Hall & Hord, 1987) can guide professional developers by unfolding stages of Concerns and Levels of Use of teachers who engage in a process of change related to science instructional practices. Professional developers who recognize where an individual teacher is in the change process may be more successful than those who rush hastily into the content of a session with little or no effort to get to know their respondents. Therefore, listening to the kinds of questions being asked and the way each teacher is applying the new innovation allows the professional developer to accurately understand which stage an individual teacher is in.

Innovation Configurations is the third diagnostic dimension of the Concern-Based Adoption Model and it focuses on how the innovation is being implemented by an individual teacher (Anderson, 1997).

Chapter Summary

This chapter presented a review of relevant literature related to this study. Particularly, I included a historical overview of professional development, research on the professional development of science teachers, and types of professional development and their features. In this chapter, a theoretical framework was derived from the existing literature and identified as a basis for the investigation to understand the professional development learning experiences of Tanzanian secondary school science teachers. Some challenges encountered, such as policy-makers and course developers in the implementation of effective professional development activities, were also pointed out.

This chapter also provided an overview of the inquiry-based approach and presented its historical basis. The benefits and challenges of implementing the inquiry-based approach were discussed, and levels of the inquiry-based approach were expounded. This study also specified forms of teaching knowledge, and inquiry-based professional development studies were presented. Furthermore, the steps needed for becoming an inquiry-based teacher were identified, and lastly, the adult learning theory of andragogy was described.

The next chapter discusses the methodological components necessary to complete this qualitative study. Components, such as the conceptual framework, research design, limitations of this study, data collection and data analysis, will be discussed in the following chapter. In summary, three research instruments were used for data collection. These included semi-structured interviews, classroom observations and a document review.

CHAPTER 3

METHODOLOGY

The purpose of this study was to (a) understand how the professional development learning experiences of Tanzanian secondary school science teachers influence their instructional practices, and (b) examine the approaches that science teachers utilize in the classroom, specifically the inquiry-based approach.

Research questions

1. What kinds of professional development opportunities do science teachers receive?
2. What methods do Tanzanian secondary school teachers use to teach science to their students?
3. How do science teachers come to understand and make sense of what an inquiry-based approach means in teaching science?

This chapter discusses the methods of inquiry, data collection, and analysis for this study which is qualitative in nature. The chapter will justify the reasons for using a qualitative case study as a research method. Purposeful sampling was employed to select participants and the criteria and process for selecting the 13 participants will be discussed. The data collection process and data sources, including interviews, observation and document review will be discussed in detail. Data analysis, ethical consideration, and subjectivities that may have been encountered over the course of the research will be described. Finally the design of the research will be assessed by proven criteria to validity and the summary of the research methodology and data collection design will be provided in the conclusion of the chapter.

Appropriateness of the Qualitative Research Method

Qualitative research seeks to understand the meaning that people attach to their own experiences, and because these experiences cannot be quantified, they must be described (Ritchie & Lewis, 2003). Qualitative research infers that reality is constructed by individuals in interaction with their social worlds (Merriam, 2009). Qualitative study seeks to understand the participants from their own perspectives (Charmaz, 2006), and focuses on how individuals interpret and make sense of their experiences and the world in which they live (Meriam and Simpson, 1995). Descriptive data are key to qualitative research (Bogdan & Biklen, 2003) and therefore, the participants' own descriptions of their social experiences frame the data in this study.

A qualitative method was chosen for this study primarily because of its value in uncovering the meaning individuals give to events or situations they experience (Bogdan & Biklen, 2003). This approach helps explore and generate knowledge about the perspectives, experiences, and teaching practices of the participants and what lies at the core of their lives through their responses to the questions asked. Employing a qualitative approach, the researcher gathers extensive amounts of rich data with extensive descriptions (Charmaz, 2002). In order to collect rich descriptive data, I used a method called *fieldwork*. As part of the fieldwork, I physically went to the setting, participants, and schools to interview and observe events in their natural setting. Yin (2011) and Denzin and Lincoln (2000) supported this when they stated that qualitative research methods are suitable when studying phenomena in natural settings and when striving to understand the contextual conditions within which people live.

In particular, qualitative research is an appropriate method when the research questions are exploratory in nature (Stake, 1995). Qualitative methods underscore the researcher's role as an active participant in the study (Merriam, 2009). For this study, as the researcher, I was the key instrument in the collection of data as well as the interpreter of (data) the findings (Stake, 1995).

Conceptual Framework

In this section, I will describe the social constructivist research framework and how this philosophical structure has led to my methodological selections. Although the main purpose of qualitative research is to inductively construct rather than test hypotheses and theories (Merriam, 1998), a qualitative study has allocated places for theories. Moreover, the social context of phenomena is often under-investigated, and the philosophical assumptions researchers implicitly and explicitly make help to direct their methodological choices and methodological implications. Merriam (2009) summarized the significance of a theoretical framework in any research:

> A theoretical framework underlies all research. Theory is present in all qualitative studies because no study could be designed without some question being asked (explicitly or implicitly). How that question is phrased and how it is worked into a problem statement reflect a theoretical orientation. (p. 66)

Social Constructivist Theory

The guiding conceptual framework of this study is based on social constructivist learning theory, which provides a basis that the experiences and views of participants in a social context is the focal point (Vygotsky, 1978). That is, social constructivists believe that individuals' understanding of reality is constructively built through their experiences and subject to various interpretations and understandings among those individuals. Therefore, individuals will interpret a particular phenomenon differently. Hence, social constructivists believe that scrutinizing multiple realities requires comprehensively analytical methods of constructivist research (Gall, Gall, & Borg, 2007).

Consequently, this philosophical orientation indicates that my research is theory- and value-laden (Howe, 2009 as cited in Tillman, 2009), which means that my values as a researcher to some extent guide this research effort. Therefore, my values may influence the design, data collection, analysis, and interpretation of the research (Howe, 2009 as cited in Tillman, 2009; Merriam, 1998). As such, two main methodological results can be inferred from my philosophical orientation. First, constructive researchers must uncover means to have participants reveal their formations of social reality. To accomplish this goal, interviews are a useful method. The philosophical assumption that undergirds this practice is that individuals interpret experiences and construct reality based on their social environments.

Another consideration is the importance of the time frame of the study. Because constructivist researchers believe that the study of individuals' explanations of social reality essentially occurs at the local and immediate levels (Gall et al., 2007), they examine certain examples of the phenomenon of interest within a particular time frame. Additionally, constructivist researchers avoid positivist methods through utilizing verbal, visual, and inductive approaches. Thus, as a researcher, I bring a construction of reality to the research situation or event by interacting with participants' constructions or interpretations of the phenomenon under study.

In this qualitative case study research, I use the social constructivist perspective to examine how Tanzanian secondary school teachers' professional development learning experiences are translated to teachers' instructional practices and investigate the approaches that science teachers utilize in the classroom, specifically, the inquiry-based approach. I relied on the fact that participants construct and make meaning of their knowledge and beliefs about their professional development experiences as well as their understanding and views of inquiry-based instruction. Thus, I provide an opportunity for the participants to share their experiences in an open and flexible setting. At the same time, I, as the researcher, make interpretations and representations of the collected data based on my own beliefs, values, experiences, and understanding. As such, the interpretation becomes multifaceted. Qualitative research methods help me present who I am and where I am coming from as a researcher.

Research Design and Method

Different scholars have written substantially about the case study approach and proposed tactics for carrying out research using such an approach (Merriam, 2009; Stake, 1995; Yin, 2014). This study will be guided by Yin's (2014) definition of a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p. 16). A case study served as the design for this study. It was an appropriate approach, because I sought to understand a real-life phenomenon in-depth. I primarily aimed to understand the participants' conceptions of the phenomenon being studied. However, such an understanding involves significant contextual conditions that are vastly relevant to the phenomenon examined by my study.

Rationale for a Qualitative Case Study

Conducting a qualitative case study was beneficial in various ways. Patton (1990) pointed out that a qualitative case study method allows the researcher to study particular phenomena in rich depth. A qualitative case study method imparts an understanding of how people make sense of their experience, which simply cannot be obtained from other research methods (Merriam, 1998). A qualitative case study method provided me with an opportunity to experience and understand what methods Tanzanian secondary school teachers employed when teaching science subjects and how these teachers made sense of the inquiry-based approach. It also allowed me to examine how Tanzanian secondary school science teachers' professional development learning experiences were translated to their instructional practices. Therefore, the case study method was selected based on the criteria provided by Yin (2003).

Yin (2003) specified three criteria essential in selecting the case study research design. The first criterion of the case study is the type of research question posed. The case study favors the use of "how" and "what" questions that enable the researcher to gain a deeper understanding of participants' experiences so as to develop rich descriptions of the experience (Creswell, 2009; Patton, 2002; Merriam, 2009; Yin, 2003) and to focus on the views and perspectives of the participants (Yin, 2011). My research questions sought to investigate the methods Tanzanian secondary school teachers used to teach science to their students and how these science teachers came to understand and make sense of what an inquiry-based approach meant in teaching science. In addition, the research questions sought to investigate the kinds of professional development Tanzanian science teachers received from their designated schools and whether teachers' participation in those professional development learning experiences influenced their instructional practices.

The second criterion for choosing the case study is the extent of control over behavioral events. The case study allows little to no control over actual behavioral events (Yin, 2003). This study entailed a detailed description of teaching practices with no control over the events that occurred when teachers used various instructional methods to teach science lessons.

The third criterion for choosing a case study design is the focus on contemporary events within some real-life contexts (Yin, 2014). A key strength of the case study method involves using multiple sources of evidence in the data collection process, such as interviews, document analysis, and observation, when exploring contemporary events (Bogdan & Biklen, 2007; Yin, 2003). The context for this study was a contemporary secondary school. Various forms of data collection techniques were employed, including interviews, participant-observation, and document review.

Yin (2003) affirmed that the unique benefit for the case study is when “the “how” and “why” questions are being asked about a contemporary set of events, over which the investigator has little or no control” (p. 9). This is true of the phenomenon that was studied, because the study investigated the classroom teaching and learning atmosphere where the researcher had no influence on teachers’ facilitation of science lessons and the teaching methods used. Therefore, the purpose of this study was best achieved using a case study design satisfying the three above-mentioned criteria.

A case study can be distinguished from other types of qualitative research, because it involves studying a single unit that is intrinsically bound (Merriam, 1998). Case studies are designs used when researchers want to fully understand particular bounded units (Stake, 2002) that must be explained, described, or explored in the everyday context in which they occur (Yin, 2009).

To decide whether the case is a bounded system, the researcher needs to inquire whether there is a limit to the number of individuals involved who can be interviewed (Lodico, Spaulding, & Voegtle, 2006). If there is an infinite number of potential participants who could be interviewed or if there is an unlimited amount of time in which the research can be conducted, then the phenomenon, event, or situation is not sufficiently bounded to be considered a case study (Merriam & Tisdell, 2015). For example, there is a need to limit the number of participants interviewed or to limit the amount of time spent in order for it to be called a case study. This is supported in that “one particular program, or classroom of learners [bounded system] selected on the basis of typicality, uniqueness, success etc., would be the unit of analysis” (Merriam, 2009, p. 41). This case study is bounded by 13 science teachers of secondary schools in Tanzania.

There are various types of qualitative case studies. Merriam (2009) has highlighted the significance of distinguishing case studies according to types, qualities, and functions. According to Bogdan and Biklen (2007), there are three types of case studies: historical organizational, observational, and life histories. Researchers utilizing a historical organizational case study investigate the development of a particular organization over time. In other words, she or he investigates the phenomenon or the development of the organization by tracing the historical origin to understand how it has changed over time (Bogdan & Biklen, 2007; Merriam, 2009). This may entail interviews with individuals who have been involved with the organization over a lengthy period. The researcher still produces a holistic description and analysis of a particular phenomenon but presents it from a historical viewpoint (Merriam, 2009).

Second, an observational case study is described as a participant observation, accompanied by formal and informal interviews and documents review, and this type of case study focuses on an organization or a particular aspect of an organization, i.e., a school, classroom, or a specific group of people, such as teachers in a particular academic department (Bogdan & Biklen, 2007; Merriam, 2009). Third, seeking to collect a first-person narrative, a life history case study involves extensive interviews with one individual (Bogdan & Biklen, 2007; Merriam, 2009). For this study, I used the observational case study, because I observed science classrooms, conducted informal interviews and reviewed science teachers’ documents.

Population and Sampling

Determining the number of cases the researcher should select is wholly a matter of judgment; there are no specific rules in place (Gall et al., 2007). According to Patton (2002), selecting an appropriate sample size for a qualitative study depends on what the researcher is seeking or the breadth or depth of the information. Researchers who select a large number of individuals are seeking breadth, while researchers who are seeing depth of information would select a small number of people. Selecting a small number of participants can be very valuable, especially if the cases are rich and deep with information. On the other hand, Creswell (1998) recommended that no more than four cases be included in a collective case study.

Secondary school science teachers were the target group for this study. These were teachers who specialized in science subjects, including chemistry, physics and biology within four government-funded secondary schools that focus on science subjects in the Dar es Salaam, Arusha and Moshi regions of Tanzania. These schools included: Johari Secondary School (Dar es Salaam), Alonzo Secondary School (Dar es Salaam), Imani Secondary School (Arusha), and Olympia Secondary School (Moshi). A total of 13 participants were selected: four teachers from Alonzo Secondary School, three teachers from Johari Secondary School, three teachers from Imani Secondary School, and three teachers from Olympia Secondary School. The selection of participants was based on an approach denoted as *purposeful sampling*, which Maxwell (2013) described as a strategy in which “particular settings, persons, or activities are selected deliberately to provide information that is particularly relevant…and that can’t be gotten as well from other choices” (p. 97). I selected purposeful sampling, because I sought to discover, understand, and gain insight from a sample from which I believed I would learn the most

(Merriam, 1988). My selection of a case study is supported by Miles and Huberman's (1994) strategies. They recommended six strategies for sample selection that include the following:

1. The sampling strategy should be pertinent to the conceptual framework and the research questions. In other words, the researcher should collect data that go along with the research topic and questions, as well as the theoretical framework.
2. The researcher should select a sample that is useful; for instance, data should be rich and relevant regarding the topic or phenomena being studied.
3. The sample should improve the generalizability of the findings (i.e., a sample that permits the information to transfer). For instance, results from one study could be relevant to other contexts.
4. The sample selection should generate credible and true-to-life descriptions and explanations. In other words, the sample should be free from biases and should provide reasonable descriptions of the experiences from the study.
5. The sample selection should follow any measures used to avoid ethical issues that may destructively affect the research process. This may involve issues pertaining to the following: researcher-informant relationship, benefits and risks related to the selection of the participants, informed consent, etc.
6. The researcher should take into account the feasibility of the study in terms of research expenses, time, accessibility, and whether the sampling strategy is well-suited with the researcher's work style. The researcher's competencies are also vital for feasibility in terms of language and communication skills and her ability to cope with circumstances. (Miles & Huberman, 1994)

Population and Sampling Rationale

The researcher selected a case study that followed Miles and Huberman's (1994) sampling guidelines. The goal was to have secondary teachers who would provide rich and relevant data regarding instructional strategies used to teach science and to understand how these teachers made sense of what the inquiry-based approach meant to them based on their views and experiences. To attain this goal, during sample selection, I took into account teachers' reliability based on both the researcher's and participants' accessibility to the research venue, ethical considerations, and resources (i.e., funds). I considered the importance of selecting participants and settings that could provide me with the information needed to answer research questions (Maxwell, 2013). Thus, additionally, participants were selected based on the school in which they taught (government funded), their years of experience, gender, and subject specialization.

a) ***Access to schools****:* identifying the right sites and participants to obtain necessary permission are critical steps in a case study (Gall et al., 2007). If this is not handled appropriately, the researcher may have to terminate the study (Gall et al., 2007). Creating a good first impression is vital, because it will set the tone for the entire relationship between the researcher and participants. As Bogdan and Biklen (2003) declared, it is necessary to meet and talk with teachers and other individuals that the researcher plans to involve in order to obtain approval. For this study, I met with the headmasters at the school sites to ask for permission to interview their science teachers and whether they could help facilitate my efforts. Once they agreed, I scheduled a meeting to meet each participant and explain the study. In order to invite open and honest communication, I introduced myself as a graduate student at the University of Georgia who sought to understand instructional issues from teachers' viewpoints. My success in gaining access to these schools relied on how well I presented myself (Gall et al., 2007).

b) ***School location:*** The location or site where I conducted my research is a vital element of the research method (Maxwell, 2013). The criteria for selecting research participants and sites are supported by Patton (1990), Miles and Huberman (1994), and Merriam (1998). Miles and Huberman (1994) suggested that a researcher should keep in mind research expenses, time and accessibility. Patton (1990) reiterated that the researcher should take into account resources, time constraints, and other dynamics that strengthen the research undertaking. Merriam (2009) called this sampling technique "convenience sampling." The researcher selected a sample based on location, sites availability, money, participants, time, etc. Thus, I avoided unnecessary expenses by selecting schools that are easily accessible and the ones with more than three science teachers with which to work. I selected 13 participants within four schools, because I sought to collect a rich amount of information from those participants.

c) ***Qualities of participants****:* In terms of participants' qualities, I selected 13 science teachers with a minimum of 5 years of experience teaching, because I believed they had been working in the profession long enough to provide in-depth information that would be necessary to answer the research questions. The number of interviews was determined by the information received, because I collected data while transcribing. I evaluated whether there was new information coming in or if the point of redundancy or saturation had been reached (Lincoln & Guba as cited in Tuckett, 2004). After interviewing the 13 participants, I reached the point of redundancy, because I was not getting any new information. The specialization of subject(s) taught was a significant criterion in this study; science teachers specialized in different science subjects (chemistry, physics and biology). In order to avoid unnecessary bias in the data collection process, I ensured that I recruited participants who taught science at different levels. I covered all four ordinary levels of each secondary school; from form one to form four, within all research locations. In other words, I interviewed teachers who taught form one, form two, form three, and form four students. In terms of gender, both male and female science teachers were selected to ensure gender balance in the study.

d) ***Flexibility:*** I ensured that my participants were not inconvenienced in any way; thus, I conducted interviews in classrooms and laboratories located at the participants' respective schools. I used an informal communication approach so that the participants would feel free and comfortable enough to comprehend the issues resulting from the research topic. The interview questions were prepared in Swahili and English; however, the participants were given an option to be interviewed in either Swahili or English. All of the participants were comfortable using the English language.

f) ***Ethical relationship with participants:*** I sought to avoid any harm that may have occurred to participants as a result of their engagement in the study. I ensured that I showed respect for participants by being considerate of their privacy as well as dignity.

Researcher-Participant Relationship

Maxwell (2013) indicated the importance of cultivating a good relationship between the researcher and their participants. The relationship I establish with participants can facilitate or hinder other aspects of the study. Boeije (2010) affirmed that trust was a basic concept in qualitative research. Developing trust with participants is vital as it allows participants to settle into a "telling mode" and become willing to show or say more than they had planned to (Boeije, 2010). As long as the researcher does not betray the trust with participants, participants will be cooperative and answer questions and elaborate on certain issues (Boeije, 2010). Thus, building trust was one of the most vital parts in this study. I treated my participants in a respectful manner throughout the research process so that the research would become successful. I created a pleasurable environment for participants while generating data. Importantly, regardless of how open the participants were, I did not force them to say more than they wish (Boeije, 2010).

Merriam (1998) stated that the qualitative researcher needed to have good communication skills because a good communicator researcher gave emphasis to participants, established a relationship, asked pertinent questions and listened attentively. Listening is another important skill in this kind of research (Merriam, 1998). Merriam recommended that the researcher “look and listen everywhere” (p. 23). Throughout the study, I was a keen observer and listener. I was attentive and respectful to participants with the intention of comprehending their narratives and experiences.

Methods

Several methods of data collection can be adopted, depending on how the researcher deems reality can best be uncovered. As Yin (2014) indicated, a major strength of case study research was that researchers had the opportunity to employ multiple sources of evidence to allow the inclusion of a broader array of historical and behavioral issues. It is vital to collect data using a variety of sources, because each data collection approach has flaws, and when used alone, may not provide sufficient information to obtain the full perspective.

According to Yin (2003), a case study may involve one or more of these approaches to data collection: interviews, observations, questionnaires, documents, field notes, and audiovisual materials. Bogdan and Biklen (2007) specified the use of interview transcripts, field-notes, photographs, videotapes, personal documents, memos, and other official records. More broadly, Merriam (2009) confirmed that a case study was not limited to any method of data collection.

Instead of generating a controlled environment as experimental researchers would do, case study researchers investigate events that occur in natural settings; therefore, it is important to take this into account when selecting methods for collecting data.

For this study, I used three methods of data collection. The combination of different data collection methods may reduce the chance of bias and provides the researcher with a more comprehensive understanding of the topic being studied, in this case, Tanzanian secondary school science teachers' instructional strategies and these teachers' views and understanding of the inquiry-based approach.

Semi-Structured Interviews

Interviews were used because I seek to understand the participants' experiences and their interpretation of the world around them (Merriam, 2009). Interviews give the researcher an opportunity to collect data from participants about their views and experiences in their own words. DeMarrais (2004) defined the interview as "a process in which a researcher and participant engages in a conversation focused on questions related to a research study" (as cited in Merriam, 2009, p. 87). Interviews provide valuable information because they allow participants to offer detailed descriptions of their experiences. As Patton (1990) affirmed, interviews allowed qualitative researchers "to find out what is in and on someone else's mind" (p. 278). Merriam (2009) reminded us that interview questions needed to be open-ended and framed using every day and common language.

Interviews have been categorized in three different ways: unstructured, semi structured and structured (Gall et al., 2007; Merriam, 2009). The unstructured interview does not entail a detailed interview guide (Gall et al., 2007). This type of interview is valuable when the researcher does not have enough knowledge about a phenomenon to ask relevant questions

(Merriam, 2009). According to Gall et al (2007), the unstructured interview is quite subjective and time consuming.

The semi-structured interview entails asking a series of structured questions, and the researcher can probe more deeply with open-form questions to collect additional information (Gall et al., 2007). This interview format is beneficial to the researcher because it provides standard data across participants-- data with greater depth than that which can be obtained from a structured interview (Gall et al., 2007). The researcher who uses this interview normally has specific information she or he wants from all the participants (Merriam, 2009). Lastly, the structured interview contains a series of closed-form questions that have yes-no answers or can be responded to by choosing from among a set of short answer choices (Gall et al., 2007). The participants' responses are not followed up to gain greater depth; these questions are similar to ones found on questionnaires (Gall et al., 2007).

Rationale for Semi-Structured Interviews

In this study, semi-structured interviews were conducted using informal and open-ended questions to gain information about teachers' experiences in teaching science. I utilized protocols (see appendix A) and also probed to allow participants to articulate additional data of their teaching experiences in their own words. The purpose for conducting semi-structured interviews was to examine what instructional methods the Tanzanian secondary school teachers used in teaching science (are) and how these teachers understood the inquiry-based teaching approach and their views of this approach in teaching science to their students. Interviews helped me to uncover teachers' experiences as well as their viewpoints.

The interview protocols helped direct the dialogue between secondary school teachers and me in order to understand their experiences. Carrying out interviews assisted me in understanding the experience of participants and the meanings they created from that experience. Because this study entails understanding the perspectives of teachers regarding science instructional methods and teachers' views of the inquiry-based approach, interviews was an effective source of data.

My role as a researcher was not be to influence the reaction of participants to the questions but to probe the participants so as to clarify the question and to seek more information regarding the question and guide the participants' responses to the research purpose. I believe probing improved participants' understanding of the interview questions and further clarified their views and understanding of the inquiry-based approach while directing participants to provide information necessary to address the research topic.

In gathering the data, I used a tape recorder to record the interviews and will also took field notes. The recorded information helped me to remember what participants said and the recordings helped me in correcting errors resulting from note-taking and perhaps, add important information that I may have missed during interview sessions. At the end of the interview sessions, the interviews were transcribed using a clean transcript (Elliott, 2005). This means intonations, pauses, and other words, sounds or noises that are not useful and are used in everyday language were disregarded from the transcript. The emphasis was on the content of what teachers say so that the data remain clear and easy to read. After the transcription, I used the member check technique, whereby I returned to the respective participants and shared the transcribed data to seek additional clarification and approval as well as ensure that their narratives were accurately transcribed before they were used in the analysis process.

Observation

The study also employed observation as one of the data collection methods. Creswell (2005) defines observation as “the process of gathering open-ended, firsthand information by observing people and places at [the] research site” (p. 211). Observation permits the researcher to collect data in the natural setting of the participants (Creswell, 2005). In this study, I was interested in investigating a phenomenon within a real-life context, and a case study approach was appropriate, because it focused on a specific situation, and it articulated rich details and explained the phenomenon.

It is important to recognize that a requirement of an observational case study is to select a focus within the school setting (Mertler, 2014). Two of the advantages of using observation were indicated by Patton (2002) and these included the following: The researcher gets the opportunity to learn about issues that participants might not be willing to discuss in an interview, and the observation helps the researcher better understand and capture the context within which individuals interact. Thus, when the participants are not able to verbalize their responses or give concrete information through the interview, observational tools can be used to provide the necessary information.

I observed teachers’ classrooms in their natural setting; I observed thirteen classrooms taught by the same science teachers whom interviewed within the four selected government-funded schools. The goal was to see the methods used by secondary teachers when teaching science to their students. I focused on the teacher activities before class and during class when the lessons were delivered, and I will pay attention to the structure of the lessons, focusing on the following elements of classroom teaching: 1. What does the structure of the lessons look like (e.g., aspects of the lessons or the length of time for each lesson)? 2. How do teachers teach the lessons and what methods do they employ (e.g., lecturing, using a blackboard, or implementing inquiry)? 3. In what manner do teachers permit students to participate in the classroom activities (e.g., individually, in groups, or both)? 4. How do teachers assess their classroom instructional practices? I also viewed teachers' teaching portfolios and collected field notes during classroom observations. I observed the interaction between the teacher and students and students with students. This allowed me to see whether students were given an opportunity to interact, work collaboratively and learn from one another. In addition, observing the classroom interaction enabled me to see whether the teacher was being authoritative and thereby not allowing students to participate, contribute or talk during class. At the end of each observation, there was a follow-up short discussion which lasted approximately 10 to 15 minutes in length, to elucidate specific classroom instructional processes. Data collected through observation was collectively analyzed with those collected in interviews.

I gained an understanding into the participants' teaching practices and methods used to teach science through emphatic neutrality (Patton, 2002). In qualitative research, "an emphatic stance in interviewing seeks vicarious understanding without judgment [neutrality] by showing openness, sensitivity, respect, awareness, responsiveness; in observation, it means being fully present…" (Patton, 2002, p. 40). The purpose of this study was to collect information and not to change any of the participants' teaching practices in any way. Therefore, during observation, I remained neutral and non-judgmental toward any behavior in which participants engage.

Document Review

I consider document review as important data source to identify the instructional strategies secondary schools teachers use to teach science to students. To increase the richness, depth, and validity of the study, documents were collected and reviewed. According to Bogdan and Biklen (2003), there are three types of documents: personal documents, official documents, and popular culture documents. Personal documents are narrative descriptions of an individual's experience or actions. Official documents are those produced by "organization employees for record-keeping and dissemination purposes" (p. 58). Popular cultural documents are those "produced for commercial purposes to entertain, persuade and enlighten the public" (p. 58).

The motive for including these documents in the data collection for this study was that they corresponded with the criterion that Merriam (1998) stated: "the best primary sources are those closest in time and place to the phenomenon by a qualified person" (p. 122). The documents in this study were personal documents; these were include teachers' lesson plans, tests and assignments. Other documents included teachers' evaluation reports, teaching and learning resources, and past examination papers. My goal in reviewing documents was to investigate the instructional methods teachers use to teach science and how science teachers came to understand and make sense of what an inquiry-based approach means in teaching science.

Field Notes

The researcher's field-notes are other essential sources of data in qualitative research (Merriam, 1998). Field notes are the effects of the researcher's observations from the research context. According to Meriam (1998), field notes should be highly descriptive in the sense that the participants, the activities, the setting, the behavior of the participants, and the actions of the observer all should be described. For this study, I wrote field notes about the interviews, observations, follow-up interviews, and casual meetings with the participants.

As a Qualitative researcher, I wrote memos while gathering data and reflect on them in my research (Bogdan & Biklen, 2003). Memo writing forms a portion of the field notes, and it contains concepts that become the initial phase for analysis and interpretation (Bogdan & Biklen, 2003). It is an essential technique of keeping records of analysis (Lawrence and Tar, 2013). Memo writing occurs throughout the research process; from the beginning of the first interview to the end of the research process (Lawrence and Tar, 2013). When a researcher writes memos she or he is able to create and develop explanations of the emerging concepts and discern the interrelationships which exist between them (Lawrence and Tar, 2013).

There are three types of memos or notes that can be used to record interview or observation data (Schatzman and Strauss, 1973). These include: observational, theoretical and methodological memos. Observational memos are statements presenting events experienced mainly through watching and listening. These are also called field notes; the researcher can use them to describe an incident during the observation. The researcher uses them by writing quotations, phrases or even sentences to describe observations made in the field (Schatzman & Strauss, 1973). Theoretical memos or notes reveal how findings are derived from the data. Basically, these memos focus on the themes and findings that emerge from the data (Schatzman & Strauss, 1973). Lastly, a methodological memo is “a statement that reflects an operational act completed or planned; an instruction to oneself, a reminder, a critique of one’s own tactics” (Schatzman & Strauss, 1973, p. 101). These memos indicate any relevant issues that occur in the methodological process.

In addition to writing field notes during observation, I used theoretical memos as a tool to illustrate the relationship among concepts. I wrote memos to myself regarding methodological aspects of the study and about the emerging findings; I noted my own reactions as well as reflections of the data (Merriam, 1998). In addition to the interviews, observation, and documents, I obtained other data throughout the study, such as that from an ongoing literature review. My memos ranged from a sentence, a paragraph or even a few pages; I recorded ideas in both Swahili and English. At this step, my main concern was to write down ideas. Importantly, I dated each memo and reference the source from which it was taken (Strauss & Corbin, 1990). The Table below shows the summary of data collection method used based on the research questions:

Table 6. Data Collection Method based on the Research Questions

	Research Question	Data Collection Method	Analysis
1	What kind of professional development options do science teachers receive from their designated schools?	Interviews	Within Case Analysis Step 1: Open Coding Step 2: Axial Coding
2	What methods do Tanzanian secondary school teachers use to teach science to their students?	Interviews, Participant-Observation and Document Review	
3	How do science teachers come to understand and make sense of what an inquiry-based approach means in teaching science?	Interviews	

Ethical Considerations

I was very aware of the need to consider relevant ethical issues regarding the schools that was involved, the research participants, and all other individuals who were associated with the study in any possible way. All research entails producing valid and reliable knowledge in an ethical way (Merriam, 1988). Bogdan and Biklen (2003) specified two guidelines that are crucial to ethical research when dealing with human subjects: informed consent and protection from harm. Informed consent ensures that the participants participate voluntarily and are provided with a detailed explanation of the nature of a study, including the associated dangers and obligations. Just as important, in order to protect human subjects from harm, potential risks to subjects must be less than the benefits they might gain from participating in a research study (Bogdan & Biklen, 2003).

In this study, the guidelines revealed my understanding that willingness to participate in an interview and observation relied on how well the participants understood the purpose of the study and what it entailed. It was also crucial that I avoided words that the participants may have interpreted as coercive and that I assured them that their privacy was respected and protected. Moreover, it was useful to explain to the participants the meaning of the words *research and researcher*, because these words may be clear and understandable to the researcher but not to the participants (Bogdan & Biklen, 2003). Therefore, I defined the notion of researcher into simple phrases and I informed the participants that the data I was going to collect would help me write my final project before the completion of the program.

Informed Consent & Confidentiality

Before having communication with participants about participating in this study, I submitted a request to the Institutional Review Board for approval to conduct the study. IRB committee members reviewed my research proposal to ensure the protection of human participants. Upon approval from the IRB to carry out the study, I secured informed consent from participants. The consent form was written in English, and I ensure that all participants understood every segment of the consent form as well as my study. I handled additional ethical concerns outside of the IRB scope such as respecting participants by not misleading them, being consistently polite, and requesting for permission when quoting subjects (Rubin & Rubin, 2005). After each transcription, I rechecked the transcripts for accuracy, and I included any additional comments.

I replaced the participants' names with pseudonyms to avoid identification of individuals who provided the information. Participants' confidentiality was taken into account and was protected at all times by identifying participants with pseudonyms. Furthermore, the data was stored in an organized format to ensure safety and accessibility (Creswell, 1998). Since I used multiple sources of data collection, it was important that I prepared a well-organized storage system to keep the data. Thus, the field notes and audio tape recorder were kept in a secure locked cabinet. Boeije (2010) asserted that a good storage method enables easy retrieval for different formats of data collection. I considered the ethics requirements for carrying out field research, therefore, the hard copies of gathered data were stored in a locked filing cabinet and electronically on a password-protected computer. Three years after the completion of my study, all data will be destroyed.

Data Analysis

Miles and Huberman (1984) described *analysis* as comprising of three concurrent flows of activity, namely: data reduction, data analysis, and conclusion drawing/verification. Data analysis is the process of making sense out of data (Merriam, 2009). The process entails merging, reducing, and interpreting what participants have expressed and what the researcher has seen and read; it is a process of making meaning (Merriam, 2009). It entails "working with the data, organizing them, breaking them into manageable units, coding them, synthesizing them and searching for patterns" (Bogdan & Biklen, 2003, p. 147). Thus, I immersed myself in the data description in order to understand and interpret particular meaning segments that developed from the case study report through research instruments. There are different terms that can be used when conducting a study using more than one case. These are usually denoted as collective case studies: cross-case, multi-case, or comparative case studies (Merriam, 2009).

This was a single case study, and therefore, the “within-case analysis” (Merriam, 1998) took place. Data analysis involved preparing and organizing the data then searching for patterns and coding for the common themes discovered within the data (Creswell, 2007). The data was analyzed by using open coding described by Strauss and Corbin (1990). In the process of open coding, the data are broken down into discrete parts, closely examined, and compared for similarities and differences; questions are asked about the phenomena as reflected in the data (Strauss & Corbin, 1990, p. 62). It is the part of analysis that refers particularly to the naming and categorizing of phenomena through close investigation of the data (Lawrence & Tar, 2013). According to Strauss and Corbin (1990), coding can be carried out line by line, sentence by sentence, paragraph by paragraph, or by the entire document. I coded the transcripts sentence by sentence, because I believed that a sentence may have one topic, thus allowing it to be easy to code and to identify main ideas unlike a paragraph, which may contain multiple different topics.

I then utilized *axial coding* (Strauss & Corbin, 1990) to organize each category into subcategories that were specific within the category. According to Lawrence and Tar (2013), axial coding involves re-building the data (fractured through open coding) in new ways by establishing relationships between categories and their subcategories (p. 32). Axial codes usually signify categories that describe the open codes (Lawrence & Tar, 2013). The process of coding helped me to classify the differences and similarities between the categories (Strauss & Corbin, 1990). The connection between categories and subcategories were made; related codes were formed into patterns. These patterns were then organized into main categories to provide meaning to the transcript. The categories were organized in a way that would allow me to obtain specific themes. According to Saldana (2009), “A theme is an outcome of coding, categorization, and analytic reflection” (p, 13). After the coding and categorization, categories were reviewed to discover themes for each of the three research questions. Finally, the categories were incorporated into themes so as to present results to the research questions. This incorporation and data presentation allowed me to make a comparison of data to the theoretical framework and existing literature. Data analysis was a vital means of processing the data which was collected because I had an opportunity to communicate my learning experiences derived from this study to the readers.

Trustworthiness

In any research study, findings are assessed based on their validity and reliability (Merriam, 1988). Validity and reliability imply the degree to which the research is conducted in a meticulous and ethical manner (Merriam, 1998). The concern of validity and reliability “can be approached through careful attention to a study’s conceptualization and the way in which the data are collected, analyzed, and interpreted, and the way in which the findings are presented” (Meriam, 1988, p. 165).

Qualitative research, using the social constructivist view, maintains that reality is constructed by individuals through their interactions with their social worlds (Merriam, 2009). Qualitative researchers are interested in a deeper understanding of how people interpret their experiences, the meaning they attribute to their experiences, and how they construct their worlds within multiple realities or interpretations rather than as a single event or phenomenon (Merriam, 2009). For this reason, findings in a study differ based on the research methods employed in the study as well as the researcher’s viewpoints. Additionally, in qualitative research, the participants' descriptions or stories greatly depend on the researcher's interpretation because the researcher is the primary instrument (Merriam, 2009). The researcher is fully involved in the data collection and analysis processes rather than using an instrument such as in quantitative research. Therefore, in order to establish concrete internal validity for this study, I used the criteria below for assessing the validity of a qualitative research design.

Internal Validity

According to Merriam (1988), internal validity asks "how one's findings match reality" (p. 166). Merriam (1988) affirmed that internal validity is regarded as the strength of qualitative research, because it attempts to interpret the participants' reality. Understanding participants' reality rests upon the researcher's interpretations, and it is important that she constructs the meaning reliably. Patton (2002) describes the term "triangulation" as a significant way to strengthen a study. Triangulation is a distinctive feature of case studies as it involves the use of multiple data sources in an investigation to test and corroborate for consistency in findings (Patton, 2002). Comprehending inconsistencies in findings across different types of data can be illuminative (Patton, 2002). The reliability and validity of a study increase by means of triangulation from multiple data sources (Patton, 2002; Yin, 2014).

To ensure internal validity, I used multiple sources of data to confirm the emerging findings (Merriam, 1988). By using member checks, I took data and interpretations back to researched individuals and obtained feedback by asking them if the results are plausible (Merriam, 1988). In other words, I shared my findings with each participant by providing him or her with copies of interview transcripts, observation notes, and a document analysis report. This gave participants an opportunity to evaluate whether or not the transcriptions were precisely what they intended to express and what actually emerged in the interview sessions, classroom observations, and document review, thus ensuring research data credibility. In case errors were detected by participants, they would be corrected immediately. I used peer examination when I requested my colleagues to comment on the findings as they emerged (Merriam, 1988). In addition, I involved participants in all phases of research; this is considered participatory modes of research. Lastly, my biases were identified as I clarified my position from the outset of the study so that readers understand what positions, biases, or assumptions influenced the study (Merriam, 1988).

External Validity

External validity involves the extent to which the results of a study can be generalized or applied to other situations (Merriam, 1988). In other words, can I apply the results I found in a study to other people or settings? Although case studies may achieve great internal validity by providing a deep and insightful understanding of a case, they have been generally critiqued for lacking external validity.

Reliability

Reliability refers to the extent to which the researcher's procedure can be replicated if the study is repeated to see if it will produce the same results (Merriam, 1988). In other words, if a different researcher follows the same procedure and carries out the same case study, will they obtain the same findings and conclusions? The strategies used to ensure that my results are dependable included: identifying my assumptions or position in relation to the group being researched, discussing the basis for selecting participants, providing descriptions of the participants, and stating the social context in which the data was gathered (Goetz & LeCompte, 1984 as cited in Merriam, 1988). In addition, I utilized triangulation and an audit trail. This means I described in detail how the data was collected and analyzed and how I made decisions throughout the study (Merriam, 1988).

Insider-Outsider Status

In this study, I entered into the research context as an insider-outsider. An insider is "someone whose biography (gender, race, class, sexual orientation and so on) give her [sic] a lived familiarity with the group being researched," while an outsider is "a researcher who does not have any intimate knowledge of the group being researched, prior to entry into the group" (Griffith, 1998, p. 361 as cited in Mercer, 2007 p. 3). I had an insider advantage, because I was born and raised in Tanzania. Since I shared characteristics, such as culture, ethnicity, and language with the individuals being researched, I was an insider. In this case, it was advantageous because it averted cultural barriers; the interaction was more natural, and I did not stereotype or pass judgment on the participants. As an insider researcher, I knew the ways and manners of approaching participants. Merriam (1998) has noted that "being a member of the group being studied may be the only way to gain access and obtain reliable information" (p. 125). I believe participants were pleased and happy to discuss matters with me because I understood them and their culture well. As Shah (2004) supported, the insider researcher can gain access more easily to participants and can effortlessly produce an environment in which participants feel comfortable and would be more willing to speak freely.

Conversely, I was an outsider, because I have been away from Tanzania for 15 years while pursuing undergraduate and graduate studies at Grand Valley State University and at the University of Georgia. Mercer (2007) regards power relations to be a concern only if the researcher holds a senior position to that of the respondents. This might not only apply in the status but also in the level of education the researcher holds. In terms of educational level and power dynamics, participants were at ease to confide in me and were open with me even though I have studied and been outside of Tanzania for a while.

It has been alleged that the insider researcher is inherently biased, because she or he is regarded as too close to the culture under study to create and raise provocative questions (Merriam et al., 2001 as cited in Greene, 2014). Researcher bias denotes the process in which the researcher's personal beliefs, experiences, and values affect the study's methodology, design and/or results (Greene, 2014). Therefore, I was cautious of projecting my viewpoints or perspectives onto participants or the data analysis (Greene, 2014). Aguiler (1981) indicated that insider's biases may be a source of both insight and error (as cited in Greene, 2014). Therefore, I ensured that I made every effort to become aware of these biases so that the harmful effects of such biases could be minimized.

Subjectivity Statement

Observing my own bias was important to my research study (Glesne, 2011). The individual I am influenced the viewpoint from which I interpreted my research. Generating a credible study requires recognizing and informing the audience of my views, personal biases, and theoretical predispositions throughout the study (Patton, 2002). Because I attended secondary schools in Tanzania and I specialized in science subjects, I had some biases, perceptions, and predispositions about how science should be taught and this may have influenced my awareness during the study. I have not taught science before; however, I have been taught science subjects in the Tanzanian context. I have had the experience of having to memorize facts given by the teacher. Moreover, I have observed and experienced how teachers conduct their classrooms; their methods do not match at all with constructivist teaching and learning methods. Although I had my own preconceptions, it was vital that I set those aside. In other words, I had to be conscious of both my biases as well as those of the teachers I interviewed. Moreover, I had to be attentive of how my interaction with the participants influenced the research process and data as a whole (Glesne, 2011).

I took into consideration different rules about human communication and relationships in various cultures. Despite the fact that I am a Tanzanian and that I speak the same language as that of the participants, I keep in mind that Tanzanians have diverse ethnic beliefs, opinions, and behaviors. In Tanzania, there are approximately 129 ethnic groups (Skinner, 2005), and each ethnic group has its own local language. As the researcher, I may not have known the participants' cultural norms, although we were all natives of the same country. This is the reason Bogdan and Biklen (2003) suggested that the researcher should take cultural norms into account by investigating the participants' beliefs and opinions instead of assuming people are willing to participate in events in the manner in which the researcher desires.

Reflexivity

Before moving and completing my high school in a different country, I partially attended one of the secondary schools in Tanzania. My specialization was in science subjects and therefore, I have had the same experiences as the currents students. In fact, since I was a class leader, almost all of my teachers gave me their notes so that I could write them on the board for them. The days that the teachers wanted me to write the notes on the board, they did not show up. I recall that in my secondary school years in Tanzania, I had strong and positive relationships with teachers. With this experience, I strived to hide my "awareness" of the teaching and learning practices taking place in Tanzanian secondary schools. Thus, before, during and after the data collection process, I blinded my presumptions as to avoid bias when it came to data analysis.

As a Tanzanian graduate professional who has lived outside of the country for many years, I needed to be aware of how my social class and status could have affected my relationship with the participants and the data collection. The fact that I have had experience living in the U.S. made many teachers wish I could pick them as my participants. I did not have a problem in terms of sample selection. Some teachers came directly to me requesting if they could be my participants. The teachers I interviewed had an opportunity to share their interests in furthering their studies in the U.S., and in our spare time, we discussed their personal issues and answered all their queries regarding American higher education. Overall, this experience was positive in different ways; firstly, to share their personal issues, participants must have trusted me highly. Secondly, if they could openly express their inner desires and feelings about their own lives, it made me believe that the information they provided to me regarding their teaching practices was genuine.

As many researchers declare that qualitative research generates rich and detailed data, I do agree because I had an opportunity to obtain large and rich amounts of data in the participants' own words. However, after the data collection process, I believe that in qualitative research, rigor is difficult to assess and demonstrate. At many different phases, I asked myself how I could make my research credible, and I wished to proclaim that I am a female novice researcher who sought to investigate the professional development learning experiences of science teachers in Tanzania. I ensured that I abided by the qualitative methodology literature that presented the research process as linear given that the researcher follows the principles and takes into consideration the reliability and validity of their study (Patton, 1990).

I appropriately and politely entered the researched schools and approached the school officials respectfully and thus, I was accepted by all. Throughout my data collection process, I demonstrated the importance of understanding, valuing, and incorporating my own culture in all phases of research. With that said, my age and gender did not play a role in giving me privilege to access schools or research participants, but my nationality played a part as I was accepted easily. During the data analysis phase, I was confused and questioned myself about how I would produce a research document that would yield meaningful results and knowledge. Thus, I immersed myself in other literature and discovered other researchers who also had to overcome these hurdles with the implications of concepts such as reflexivity.

Although I observed participants' classrooms, my primary data collection method was conducting interviews; therefore, I recognized myself as a central part of the research process, playing the role of both a data collection instrument and a researcher (Merriam, 2009). These were two aspects of my study. I also acknowledged reflexivity as an important concept. As Hsiung (2008) stated, "Reflexivity is a process that challenges the researcher to explicitly examine how his or her research agenda and assumptions, subject location(s), personal beliefs, and emotions enter into their research" (p. 212). This consciousness of me as the researcher is mirrored in the research design; I realized the connections between the epistemological and ontological standing and the data selection methods I utilized. In essence, ontology is "reality," and epistemology is the relationship between that reality and the researcher (Carson, Gilmore, Perry, & Gronhaug, 2001). Succinctly, a paradigm is an overall conceptual framework within which a researcher may work; a paradigm can be regarded as the "basic belief system or worldview that guides the investigator" (Guba & Lincoln, 1994, p. 105). As a researcher, I put into consideration the primary questions of epistemology, ontology and research paradigm, and that is what determined the choosing of methodologies (the techniques used by researcher to discover reality) and research methods (data approaches) for this study.

Generating transparency in the research process was a vital consideration, one that I engaged with through taking notes in my reflective journals at every phase in writing my dissertation. The goal was to make decisions, values, and experiences behind those decisions visible, both to myself as a researcher as well as to the readers.

As a researcher, I reflected on the superior and trusted relationship that developed between me and the participants as well as on my responsibility to carry out a valid and reflexive analysis and report that incorporated participants' narratives in manners that were truthful and reflective of their needs regarding their participation. In addition, I reported and discussed my findings indicating that the particular settings of the research study and its sample cannot be generalized or applied to other situations.

I had an unanticipated outcome in terms of member checking. Member checking is regarded as a significant aspect of determining accuracy, credibility, and validity (Koelsch, 2013), and it is also referred to as member validation (Koelsch, 2013; Sandelowski, 1993). Sharing my interpretations with participants raised awareness and led to change. One of my participants communicated with me and informed me that she did not realize she had expressed herself so much and it appeared more noticeable in writing than in speaking. On the other hand, she thought that the statements were an accurate reflection of what she had said and how her professional development learning experience had been. Then, she asked me to modify the title of her Bachelor's degree. Thus, the action was taken immediately.

My participants interpreted their experiences and constructed reality based on their social environments; therefore, one event was interpreted differently by different participants producing many interpretations, and this provided a depth of understanding regarding that experience. Thus, I relied on the fact that participants construct and make meaning of their experience or beliefs about their professional development learning experiences as well as their understanding and views of inquiry-based instruction. For this reason, I provide an opportunity for every single participant to share their experiences in an open and flexible setting. As the researcher, I made interpretations and representations of the collected data based on my own beliefs, values, experiences, and understanding. As such, the interpretation became multifaceted.

Chapter Summary

The purpose of this chapter was to describe and explain the research design and methodology for this study. This research employed case study as appropriate research methodology and discussed and defined the research methods that were used to investigate the instructional strategies that secondary school teachers in Tanzania use in teaching science to students. I included the Social constructivist and sociocultural theories which led theoretical and practical decision making. Furthermore, the chapter explained the sample selection and described the procedures that were used in designing the instrument and the data collection. In addition, the researcher provided reasons and justification for the research design, data sources, research instruments, and data collection techniques. The chapter also provided an explanation of the procedures for analyzing the data.

In Chapter Four, I provide a detailed the demographic background of the participants narrating the number of years they have been in the teaching profession, the subjects taught, gender and other relevant related information on the sample. In this chapter, I also presented a general view of the Tanzanian educational system and give a description of my research clearing process. In Chapter Five, I present findings from the data gathered by exposing participants' own descriptions of their experience. In Chapter Six, I give a summary of the finding, make connections to the literature and provide recommendations and implications for further study.

CHAPTER 4

THE CONTEXT: TANZANIAN EDUCATIONAL SYSTEM

The purpose of this study was to (a) understand how the professional development learning experiences of Tanzanian secondary school science teachers influence their instructional practices, and (b) examine the approaches that science teachers utilize in the classroom, specifically the inquiry-based approach.

Research questions

1. What kinds of professional development opportunities do science teachers receive?
2. What methods do Tanzanian secondary school teachers use to teach science to their students?
3. How do science teachers come to understand and make sense of what an inquiry-based approach means in teaching science?

Background

Tanzania is located in Eastern Africa and is surrounded by Kenya and Uganda to the North; Burundi, Rwanda and the Democratic Republic of the Congo to the West; Malawi, Zambia, and Mozambique to the South; and the Indian Ocean to the East. The name Tanzania is derived from the uniting of two countries, Tanganyika and Zanzibar. The union of these two countries occurred in 1964 to form the United Republic of Tanzania (Osaki, 2007).

The Tanzanian educational system is divided into primary, secondary, and tertiary levels (Anangisye, 2010). The primary level is seven years, and it is compulsory (Anangisye, 2010). Transferring from primary schools to secondary schools requires students to pass Standard 7, which includes passing a national examination called the Primary School Leaving Examination (PSLE). Therefore, students' performance on the PSLE determines their opportunities to continue to secondary school. The secondary level is comprised of Forms 1-6. Forms 1-4 are called the Ordinary Level, and Forms 5 and 6 are called the Advanced Level. In Form 4, students are required to take a national exam (Anangisye, 2010). If they pass, they may continue on to the Advanced Level for two years. Those who continue to the Advanced Level will take a final national examination, and if they do well, they will advance to higher education. If they do not do well, they normally become an Ordinary Level teacher or find other employment (Anangisye, 2010).

The curriculum for teacher education in Tanzania is centrally controlled by the Tanzanian Institute of Education and examined by the National Examination Council of Tanzania. The teacher education curriculum encompasses general studies and studies related to students' intended fields of teaching and teaching practice (Hardman et al., 2012 p. 826).

Before examining the history of science pedagogy in Tanzania, it is significant to understand the current structure of the educational system. Secondary education in Tanzania is administered by the Ministry of Education and Vocational Training (MOEVT). The MOEVT also oversees departments such as teacher education, inspectors of schools, administration and personnel, and policy and planning as well as basic (pre-primary and primary) education and vocational education (Vavrus & Bartlett, 2013). Moreover, the Prime Minister's Office of Regional Administration and Local Government (PMO-RALG) plays a role in the management of basic and secondary education (MOEVT Mainland and MOEVT Zanzibar, 2008 as cited in Vavrus & Bartlett, 2013). There is also a Ministry of Higher Education, Science and Technology (MHEST), which is responsible for the founding of policies and supervision for the country's universities, including the faculties (departments) of education that offer bachelor's and master's degrees in education. Overall, the country's teacher education system, which includes teachers' colleges and universities, is operated by both the MOEVT and MHEST (MOEVT, n.d., "Teacher Education Division" as cited in Vavrus & Bartlett, 2013).

Pre-service Teacher Training:

Pre-service teacher training prepares an individual for a teaching career. The training makes it possible for future teachers to understand educational theories, education philosophy, teaching methodologies, and educational ethics while gaining social skills and knowledge in different subjects prior to starting their teaching careers. A teacher is required to master her or his area of specialization so as to be in the best position to assist students.

There are two tiers of teacher education in Tanzania, named college-based and university-based teacher education (Meena, 2009). Teachers who successfully graduate from college-based teacher education are eligible to teach in pre-primary, primary and lower secondary school, while the graduates from universities' teacher education programs qualify to teach upper secondary education, certificate and diploma teachers' college education.

Structure of the Teaching Workforce in Tanzania

There are five levels of teachers in Tanzania, differentiated by the degree of preparation (World Bank, 1999). The first three are classified as Grade C, B and A, depending on the pre-service qualifications and training. The other two are Diploma and Degree holders. I outline the various categories below.

Grade C schoolteachers usually have a primary (grade 1-7) education, and receive a "crash course" (short course) in teaching methodology before being deployed to teach the lower grades in primary schools throughout the country. Grade C teachers later upgrade to Grade B through intensive in-service training in order to remain competitive (World Bank, 1999).

Grade B schoolteachers also enter teacher training programs with a primary-school education. They then study general education for two years (the equivalent of form II education) and another two years learning how to teach primary-school subjects. Upon graduation, these Grade B teachers are eligible to teach in primary schools (World Bank, 1999). Grade B teachers can also upgrade to Grade A, in a two-step process. They must upgrade to O-level, meaning they need to attend an “in-service” correspondence course or private secondary schooling. Once they pass their O-level examinations as private candidates, they qualify for a one-year training course in methodology to attain Grade A status (World Bank, 1999).

The prerequisites for Grade A school teachers are O-level’ education (Form IV certificate) and a pass grade in at least four subjects in Form IV National exams. Their training takes two years during which they learn how to teach 11 primary subjects and acquire diverse knowledge and skills in classroom instructional methods. At the end, they are required to do teaching practice in order to graduate. Most Grade A teachers are employed to teach in primary schools. In the past, however, a few taught in secondary schools, and a very small number in teacher-training institutions. Grade A teachers can upgrade to diploma level through an intensive two-year program. The training covers material for A-level in the first year, and then the diploma-level training in the second year. To upgrade from Grade A, a teacher must have achieved at least 3 credits at O-level and 3 years of teaching experience.

Diploma-level teachers enter teacher training with A-levels (Form VI). Those completing the two-year course are hired to teach in lower secondary schools as well as teacher-training colleges (World Bank, 1999).

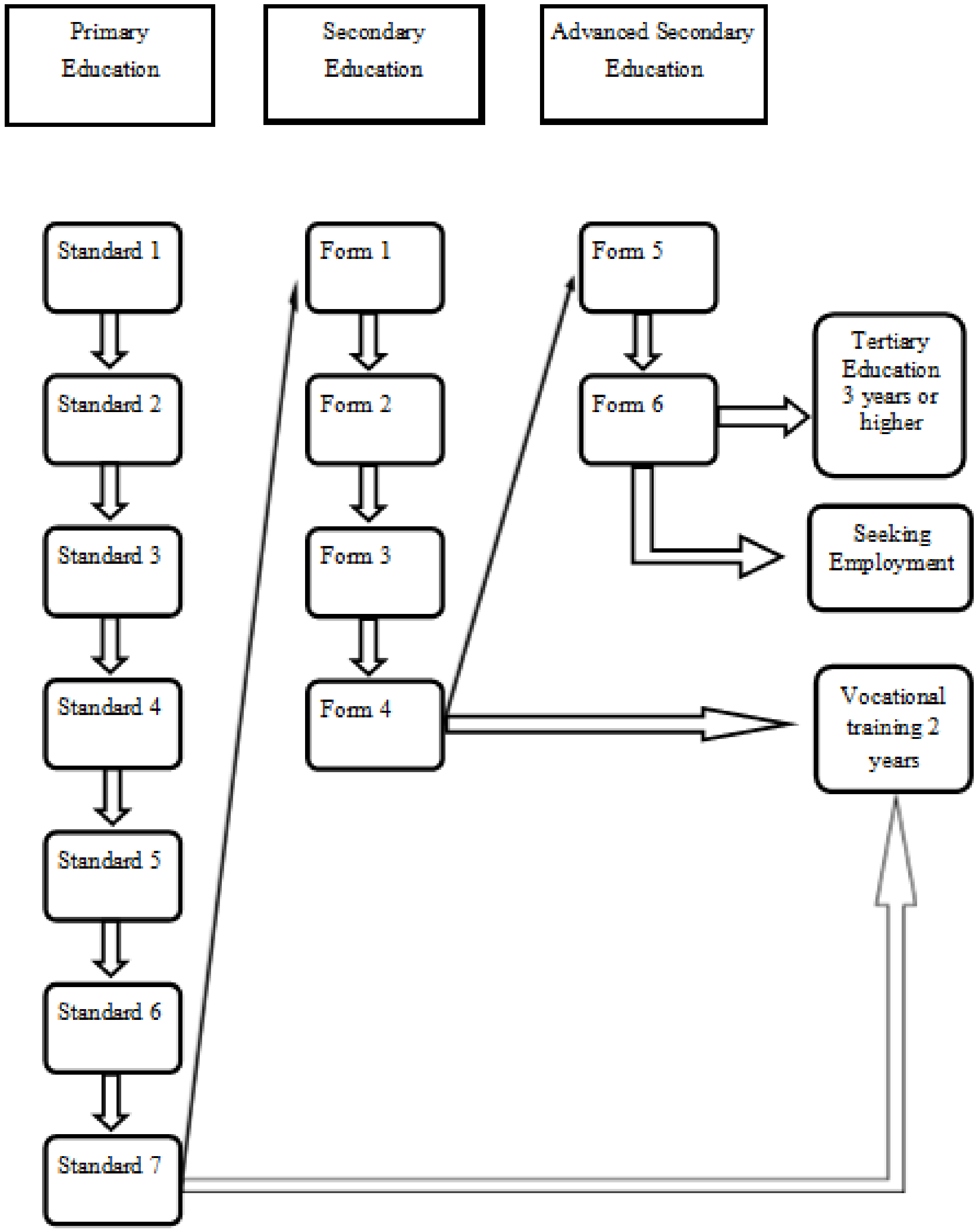

Figure 1. Structure of the Tanzanian Educational System

The Research Clearance Process

This study was conducted in Tanzania, the regions of Dar es Salaam, Moshi and Arusha regions of Tanzania. As a researcher, I am a Tanzanian citizen, who is a doctoral student at the University of Georgia in the United States. There were some measures of the Tanzanian research protocol that I had to follow and complete before initially conducting research. Based on the Tanzanian Education Research Policy, any research study involving pre-primary to secondary education must be approved by the Ministry of Education administrative offices, and Commission for Science and Technology (COSTECH).

Basically, irrespective that I am a Tanzanian studying abroad, I was required to get the research approval because I was in need of conducting research in the country. So, after two days of my arrival in Tanzania, I visited the COSTECH offices to inquire about the research clearance application procedures. I was told to submit an application form, a research proposal, a curriculum vitae, US$50 (for a Tanzanian researcher) and three passport size photographs. The following day, I returned to the office with all the required documents. I am grateful that the person who was assisting me expedited the service and within a week and a half, my permit was approved and I was called to pick it up. The permit was granted for a period of one year.

After obtaining the approval, I had to apply for another research permit to allow me to conduct research in the city of Dar es Salaam. I applied this subsequent research permit at the Reginal Commissioner’s Office which directly manages the delivery of pre-primary, primary, secondary and teachers’ education. In this office, I was required to submit a copy of the permit obtained from COSTECH, a letter to Dar es Salaam Regional Commissioner requesting permission to conduct research in Dar es Salaam, specifically in Msifuni district (Pseudonym). I also filled out a form and signed it, then I submitted all the documents. I was told to come back in three days to get the permit.

After receiving the permit, I was required to make the last research permit request at the Municipal Council. The Municipal Director oversees the process and delivery of secondary education and report the overall status of education to the Regional Commissioner's Office. Thus, I presented both the permits I received from COSTECH and the Regional Commissioner's office to the office of Municipal Director who supervises the secondary schools located in the district in which my research study took place. After a few days, I was provided with a permit to present to the headmasters and headmistress of the secondary schools in which the study was conducted. From this point, the process of negotiating on gaining access to the research sites and selection of participants depended sorely between the headmaster/headmistress of the school and myself. Overall, the research clearance process and obtaining all research permits felt like a demanding job because I had to go through the same procedures for Moshi and Arusha regions. I could not have begun the research before obtaining research permits for all the three regions in which the study was conducted.

Description of the Participants

Thirteen science teachers from four government funded secondary schools participated in this study. All of the teachers have been in the teaching professional for more than five years, their ages range from 25 to 55, and they all teach science subjects to ordinary level students. Although all of the teachers have had opportunities to attend various professional development events, their attendance at those sessions differs for each individual teacher. Table 7 provides an overview of each participant, their years of teaching, the school where they teach, the grade they are currently teaching and a factor(s) that intrigued the teachers to teach science rather than other subjects.

Table 7. Description of the Participants

Name of Participant (Pseudonym)	Name of Secondary School Pseudonym	Gender	Teaching (yrs.)	Teaching Grade Level	Education	Intriguing Factor Making Them Want to Teach Science
Albert	Alonzo	Male	15	Form 2	Degree in Physics and Mathematics	His family members studied science.
Alpha	Alonzo	Male	23	Form 4	Diploma in Biology and Chemistry	He always wanted to be a science teacher to inspire the lives of the next generation of scientists.
Rubi	Alonzo	Female	26	Form 2	Diploma in Physics and Mathematics	She always wanted to learn and teach subjects that make her think, investigate and find answers, rather than cramming.
Muller	Alonzo	Male	18	Form 1	Diploma in Education (Biology and Chemistry)	He wanted to be a doctor, but he was not able to succeed as a doctor; Instead, he decided to become a science teacher.
King	Johari	Male	17	Form 3	Diploma in Education (Physics and Mathematics) and Bachelor in Education (Mathematics and Economics)	He was inspired by his mathematics and physics teachers' ways of instructing. He followed in his teachers' paths by being a science teacher.
Vivian	Johari	Female	11	Form 4	Bachelor of degree in Education (Physical sports and culture and Biology).	She performed very well in her science studies and was selected to continue studying science subjects.
Simona	Johari	Female	37	Form 3	Bachelor of Science with Education degree (Chemistry and Biology)	She was very good at chemistry, physics and mathematics and performed very well. She wanted to have a profession that involved science.
Viola	Imani	Female	5	Form 1	Bachelor of Science with education (Chemistry and Biology)	Vivian's interest in teaching science stemmed from students complaining science subjects were so hard. Vivian wanted to be an example to ensure her students that the subjects are not as hard as they think.
Peter	Imani	Male	15	Form 3	Bachelor of Science with Education (Physics and Chemistry)	Peter had higher marks in science subjects than art subjects, because he found science subjects to be easy. He enjoys physics, because he uses formulas and calculations to obtain short answers, unlike in art subjects, where one has to explain and write long essays.
Sydney	Imani	Female	25	Form 3	Bachelor of Education in Chemistry	Sydney was influenced by one of her chemistry teachers. Her teacher was very passionate about chemistry and that made Sydney direct her studies to chemistry teaching.
Leila	Olympia	Female	15	Form 1	Bachelor of Business Administration and a Diploma of Education in Science (physics and Mathematics)	Leila was inspired by her secondary school teachers' ways of teaching science subjects.
Rosanna	Olympia	Female	9	Form 3	Bachelor of Education in Chemistry and Biology and a Diploma of teaching methodology in education.	Rosaline wanted to be a doctor, but she could not accomplish that goal. She took a different route and became a science teacher.
Theodora	Olympia	Female	27	Form 2	Bachelor of Education in Chemistry and Biology	Theodora was attracted to science by her secondary school teachers. She performed very well in her science classes, and she had the passion to become a scientist. That did not work out, however, and she became a science teacher.

Alonzo Secondary School (Dar es Salaam)

Albert

Albert has been teaching Physics and Mathematics for 15 years in private schools and government schools. Out of those years, he had taught form four Physics students at Alonzo Secondary School for five years. Although Albert was very good at business classes and his Business class teacher convinced him to concentrate on business, Albert still selected science subjects. He likes Physics, because he finds he can be his own handyman at home, instead of finding someone to perform these duties for him, for example, setting up electricity. Albert's interest in teaching science stemmed from his family; his mother, his sister, and other family members all studied science subjects, and he decided to follow in their footsteps. Albert stated that "I am teaching in order to get scientists; otherwise, we can't have them." Albert has a degree in Physics and Mathematics.

Alpha

Alpha has been a science teacher at Alonzo Secondary School for twenty-three years, teaching Chemistry and Biology with his focus being Chemistry. Alpha's goal when he was young was to be a science teacher. His dream came true when he started teaching Form One to form four students. He is very passionate about the subjects he teaches, and one of Alpha's main objectives when it comes to teaching is to inspire students and to help shape the lives of the next generation of scientists. Alpha holds a diploma in Biology and Chemistry.

Rubi

Roxanna has been a science teacher at Alonzo Secondary School for twenty-six years. She is proud to be a Physics and Mathematics teacher. Her main subject is Physics, although she can tutor students privately in Mathematics. Roxanna indicated that although there are so many circumstances in teaching Physics at her school, she teaches it with all her heart. For many years, she taught form four students, but later on, she was required to start from form one and continue with them until form four. Roxanna holds a Diploma in Physics and Mathematics.

Muller

Gerald has eighteen years of experience teaching science at Alonzo Secondary School. He teaches Biology as his specialty subject, but he is able to teach Chemistry, as well. Gerald teaches form one to form four students. Before he started teaching at Alonzo Secondary School, he taught at two different government funded secondary schools. Gerald's ambition was to be a doctor; however, the required Chemistry and Biology classes were challenging for him, and he was not able to succeed as a doctor. Instead, he decided to become a science teacher. Gerald possesses a Diploma in Education (Biology and Chemistry).

Johari Secondary School

King

King is a science teacher at Johari Secondary School. He has been teaching Mathematics and Physics for seventeen years. His specialty is Physics. King's passion was to be a scientist, because his former Mathematics and Physics teachers' ways of instructing impressed and inspired him. So, he decided to follow his teachers' paths by changing his ambition to being a science teacher. King mentioned that while in school, he put a great deal of effort into his education, and he performed very well in science. He confessed that he is not just teaching science by chance, as his hard work had paid off. King holds a Diploma in Education (Physics and Mathematics) and a Bachelor's degree in Education (Mathematics and Economics).

Vivian

Vivian started teaching at Johari Secondary School eleven years ago. She teaches different levels starting from form one to Form Four. Vivian specializes in Biology, and she holds a Bachelor's Degree in Education (Physical Sports and Culture and Biology). She pointed out that she performed very well in her studies and was elected to continue studying science subjects. She enjoys teaching Biology, because she continually learns about organisms. She also takes pleasure in her work, because her and her colleagues share their experiences and challenges and help one another.

Simona

Before teaching at Johari Secondary School, Simona taught at several private schools. Simona has been in the teaching profession for thirty-seven (37) years. She started teaching Chemistry and Biology at Johari Secondary School twenty-five years ago with Chemistry being her specialization. She teaches from form one to form four. When she was still in school studying, she was very good at Chemistry, Physics and Mathematics. She began reading science books, and she performed really well in her classes. Simona is very interested in science as she specified that she automatically became a very competent teacher due to reading lots of different science books. Simona holds a Bachelor's of Science with Education degree (Chemistry and Biology).

Imani Secondary School

Viola

Viola is a teacher of Chemistry at Imani Secondary School. She has been teaching form one to form four students Chemistry, and she feels comfortable teaching science. She confessed that she is proud to be a science teacher, because there are a few teachers who want to teach science, because they assume that disciplines in science are difficult to learn and teach. Even Viola's students think science subjects are difficult, and they often fear taking them. However, Viola manages to explain to her students that the subjects are not as hard as they think. She assures them that if the classes were hard, she would not have taken them herself. Vivian mentioned that she became a science teacher to encourage those students who think they cannot be successful in science. She wanted to be an example to her students. Viola possesses a Bachelor's of Science with Education (Chemistry and Biology).

Peter

Peter has been a physics teacher for fifteen years. His interest in science stemmed from the time he was in primary school to secondary school. He had higher marks in science subjects than art subjects, because he found science subjects to be easy. He claimed that in Physics, he uses formulas, calculates, and obtains short answers, unlike in the art subjects, where one has to explain and write long essays that he did not enjoy. This is the reason Peter chose science, which he enjoys immensely. Peter teaches form three students, and he holds a Bachelor's of Science with Education (Physics and Chemistry).

Sydney

Sydney has been teaching for twenty-five years, and the only subject she teaches is Chemistry. When she was in secondary school, she was influenced by one of her Chemistry teachers. She mentioned that her teacher was very passionate about Chemistry, and that made Sydney direct her studies to Chemistry. Sydney teaches form three students. She holds a Bachelor's of Education degree in Chemistry.

Olympia Secondary School

Leila

Leila is a science teacher at Olympia Secondary School. She has been teaching Physics for fifteen years; although she has only been teaching Form One students at Olympia Secondary School for seven years. Leila was inspired by her secondary school teachers' ways of teaching science, and that is the reason she became a science teacher. Leila holds a Bachelor's of Business Administration degree and a Diploma of Education in Science (Physics and Mathematics).

Rosanna

Rosanna has been teaching at Olympia Secondary School for nine years. She is a Chemistry and Biology teacher to form one to form four students, however, she only teaches Chemistry at Olympic Secondary School. Initially, Rosanna's passion was to be a doctor, but since she could not accomplish that goal, she decided to take another route and become a science teacher. Rosanna holds a Bachelor's of Education in Chemistry and Biology and possesses a Diploma of Teaching Methodology in Education.

Theodora

Theodora has been a science teacher for twenty-seven years. She joined Olympia Secondary School in 1993, so she has been a teacher at this school for 23 years. Before joining Olympia, she was teaching at private schools. Theodora can teach Biology and Chemistry. She teaches Biology as her main subject; however, if there is a shortage of Chemistry teachers, she fills that gap, as well. Theodora became fascinated by Science through the tutelage of her secondary school teachers. She performed very well in her Science classes, and she had a passion to be a scientist. Her plans to be a scientist did not go as planned, so she decided to become a science teacher instead. Theodora possesses a Bachelor's of Education in Chemistry and Biology.

Chapter Summary

This chapter focused on the context of the study, which is Tanzania. The chapter introduced the 13 participants who participated in this study and their background information was presented. The researcher's clearance process was described and the Tanzanian Educational System was clarified in both words and table.

CHAPTER 5

FINDINGS

The purpose of this study was to (a) understand how the professional development learning experiences of Tanzanian secondary school science teachers influence their instructional practices, and (b) examine the approaches that science teachers utilize in the classroom, specifically the inquiry-based approach.

Research questions

1. What kinds of professional development opportunities do science teachers receive?
2. What methods do Tanzanian secondary school teachers use to teach science to their students?
3. How do science teachers come to understand and make sense of what an inquiry-based approach means in teaching science?

The design of this study was qualitative; I used interviews as the primary method of data collection and also utilized participant-observation and document review as the secondary source of data collection. I interviewed 13 Tanzanian secondary school science teachers who had been in the teaching profession for more than 5 years. All the interviews were transcribed verbatim. Since this is a qualitative study, it reports the viewpoints of each participant as well as the researcher. The participants' quotes revealed the individuality and unique experiences of each participant. This chapter presents themes, sub-themes, and sub-sub-themes that were identified from the data analysis. The findings of the study will be described in this chapter. The Table below shows the summary of the findings of this study.

Themes of the Study

The analysis of the data discovered themes that addressed research questions and also provided an understanding regarding the professional development learning experiences of secondary school teachers and their use of inquiry based approach for teaching science. This section discusses the five themes that derived from the data analysis. The five main themes (see Table 8) that emerged within the findings were (1) Science teachers experience a range of access to government sponsored programs and generally have negative perceptions associated with the quality and availability/access of programs, (2) Science teachers were self-directed in individually seeking PD through both higher and continuing education, (3) Teachers use teacher-focused, traditional methods to teach science, (4) Governmental resources, insufficient professional development, and curriculum demands inhibit teachers from using modern teaching approaches and (5) Based on governmental constraints and professional development of teachers, teachers are not aware of the inquiry-based approach. Below, Table 8 provides a synopsis of all the major themes, sub-themes and sub-sub-themes that merged from the gathered and analyzed data

Table 8. Overview of the Findings of the Study

RQ and how it is answered	Themes	Subthemes
What kinds of professional development opportunities do science teachers receive?	Science teachers experience a range of access to government sponsored programs and generally have negative perceptions associated with the quality and availability/access of programs.	• Government sponsored programs o Privileged access o Experienced little or no access • Perceptions of the quality of professional development o Uneven/biased based on: ✓ Teacher popularity ✓ Taking turns ✓ Performance o Insufficient professional development o Lack of transfer o Lack of incentives
	Science teachers were self-directed in individually seeking PD through both higher and continuing education.	• Self-directed programs o Bachelor's degree o Computer courses
What methods do Tanzanian secondary school teachers use to teach science to their students?	Teachers use teacher-focused, traditional methods to teach science.	• Instructional Strategies o Lecture o Demonstration • Motives for choosing didactic-focused method o Non-instructional strategies lessons are taught in seminars ✓ Grading exams ✓ Syllabus modification and tough science topics ✓ Special needs' students ✓ Using improvised tools
	Governmental resources, insufficient professional development, and curriculum demands inhibit teachers from using modern teaching approaches.	• Lack of contemporary instructional delivery methods due to the limitations of tangible instructional materials o Lack of teaching resources o Inadequate labs and tools • Conflict between government policy and education practices o Less consideration of real classroom conditions ✓ Syllabus length • Over-emphasis on the National exam
How do science teachers come to understand and make sense of what an Inquiry-Based Approach means in teaching science?	Based on governmental constraints and professional development of teachers, teachers are not aware of the inquiry-based approach.	• No experience in using inquiry as a mode of delivery of instruction o Unawareness of inquiry o Project as inquiry
	Other findings	• Poor service conditions and low work morale o Lack of motivation o Low salaries o Shortage of teachers and teacher incompetency o Overworking • Classroom management difficulties o Large classroom • An informal meeting forum o Peer-support

RQ: What kinds of professional development opportunities do science teachers receive?

Type of professional development opportunities provided

This section discusses the themes based on the first research question. The findings for the first question describe the professional development that Tanzanian Secondary school teachers receive. The answers to this question are based on the learning experiences of the science teachers and their perceptions about the professional development options in general. The data produced two themes that are related to the provision of professional development: (a) Science teachers experience a range of access to government sponsored programs and generally have negative perceptions associated with the quality and availability/access of programs and (b) Science teachers were self-directed in individually seeking PD through both higher and continuing education. Table 8 provides a synopsis of the key themes and subthemes that emerged

Table 9. Type of Professional Development Opportunities

RQ and how it is answered	Themes	Sub-themes
What kinds of professional development opportunities do science teachers receive?	Science teachers experience a range of access to government sponsored programs and generally have negative perceptions associated with the quality and availability/access of programs.	• Government sponsored programs o Privileged access o Experienced little or no access • Perceptions of the quality of professional development o Uneven/biased based on: ✓ Teacher popularity ✓ Taking turns ✓ Performance o Insufficient professional development o Lack of transfer o Lack of incentives
	Science teachers were self-directed in individually seeking PD through both higher and continuing education.	• Self-directed programs o Bachelor's degree o Computer courses

Theme: Science teachers experience a range of access to government sponsored programs and generally, have negative perceptions associated with the quality and availability/access of programs.

This is the first theme which answers the question about the kinds of professional development opportunities that science teachers receive. There were government sponsored programs in which not every teacher had access, thus, this translates to professional development not offered and distributed equally. Some of the participants participated while others did not get an opportunity to take part in them due to circumstances which are not in their control. This theme has three sub-themes which include (a) Government sponsored programs (b) Self-directed programs and (c) Perceptions of the quality of professional development. All the three sub-these will be explained in detail in the following section.

Government sponsored programs

This sub-theme describes the programs that are provided by the government. The sub-theme is divided into two sub-subthemes which are (a) privileged access and (b) experienced little or no access

Privileged access

This sub sub-theme indicates that there is a teacher who has access to professional development. This teacher has an opportunity to attend professional development opportunities that are funded by the government. These training courses include workshops, and seminars. Only one of the 13 participants confessed that he received professional development opportunity fully and he was pleased with the opportunities he was privileged to attend.

King's case: For a teacher like King, his performance allowed him to get access to attend different types of training, and as a result he was promoted as a National trainer. According to him, teachers' performance matters when it comes to being selected to attend professional development activities. Out of 13 participants, he is the only one who attended numerous seminars and workshops nationally and internationally, and he recognizes that the opportunities he received were rewarding because he used the learning to teach other teachers across the country. In his own words, King explained,

> *First of all, you should be one of the best performers in your service. For example, one of the administration people can appoint you to go to attend the seminar. From there, they*

can start looking at your performance, how effective you are, and then they keep on training you, so I have been trained within the country and outside the country so that I might have enough skills and content to conduct the training in the country. So, I was selected because of my performance, and then I got enough trainings, seminars, workshops outside the country, and within the country, so that I can get more skills and knowledge.

King's case: According to King, his students performed very well and were rated the best in the country. King alleged that he has represented his school and the whole nation very well and the inspectors thought it would be a valuable investment to make King a National trainer so that he can train others. King pronounced,

I am a National trainer…I managed to produce the best students in the country. It was from my performance, when the inspectors came and the administrators came to see how we are doing in school they were impressed with what I am doing, so from there, I was picked to be in the national level so that I can get more knowledge, more skills. So, it was because of my performance, yeah, they saw what I was doing; they saw my capacity so they had to call me to be in the national group.

As the participant declared that he was privileged to be selected and participate in various training activities because of his remarkable performance, this raises the question of whether he was the only teacher who performed well. Being the only teacher who had access to all the training activities appeared to be bias because even average performing teachers could still be selected and be trained to enhance their teaching practices.

Experienced little or no access

This sub subtheme refers to participants who have had a partial opportunity to attend to professional development programs and those who have not had the privilege to attend to any. Four participants out of 13 indicated that since they have been working as science teachers at the researched schools, they have not attended any seminars or workshops provided by the government. These participants expressed their experiences of being science teachers for over 10 to 20 years without attending any of the professional development activities.

Albert's case: Albert understands that professional development opportunities can be valuable to improve teachers' knowledge; however, non-science teachers are provided with such opportunities and they bypass him. It got to a point where he wanted to find out why he had not been offered these professional development opportunities, and when he asked, he was told that funding is a problem. Albert explained,

> *That is the problem, yeah, that is the problem, we have those opportunities that we get a privilege to develop our studies, but for those chances we are not given the required teacher; so, you may find that another teacher has taken the chance and attends…. that's the problem that we have. But, the one [teacher)] who is in class, dealing with the students never gets that chance; that is the problem… You may find that teachers who are not dealing with science, they go for professional development to learn computer courses, but science teachers who teach the student, they never go…sometimes, we used to ask that "Why are we not going for workshops? If that teacher has gone why don't you pick maybe two teachers instead of selecting one? You take two teachers or three to learn but we are*

told the reason is that there is no money to take them to the workshop." Since I have been here, I haven't attended professional development activities.

Vivian's case: Although she has been teaching for 10 years, Vivian has not had an opportunity to attend professional development activities apart from food safety training. Teachers attend these activities in turns and hers has not arrived yet. Vivian explained,

Not really in science… since I have been teaching here for ten years, I have not attended any professional developments for science.…they offer in all science subjects, even in biology, yes, but people go in turns. However, I attended one training about food safety in Mongolia in 2008. They wanted to integrate food safety in the syllabus of biology and nutrition so they picked some of the teachers from the schools, and that one I attended.

Rosanna's case: Rosanna stated that she has never attended any professional development activities since she started teaching, but she was aware that other people such as heads of departments attend the professional development events. Rosanna articulated,

There are others individuals such as the head of departments who would go to professional development events but, myself, I have never gone.

Theodora's case: Theodora has been working at Olympia Secondary School for a long time, and she acknowledged the importance of being involved in the professional development events. However, she has not had a chance to experience these professional development activities. Theodora asserted,

I haven't received any professional development opportunities inside of the school or outside, yes, you just teach the way you know, the way you think it is, only that. So, I can *say that in more than 16 years, I haven't, I have never been involved in workshops or any other seminars which will improve my teaching.*

Conversely, five participants who were given an opportunity to attend seminars and/or workshops indicated that they have received such opportunities only once or twice for the entirety of their science teaching at the researched schools.

Leila's case: Leila teaches special needs students at Olympia Secondary School. In recent years, the school started providing training for teachers who teach these students. According to Leila, the training is offered twice a year. Leila explained:

We go twice a year…yes, we go to workshops and seminars, and we attend seminars for learning how to teaching these blind students, yeah, we attend a seminar on how to teach them.

Muller's case: After teaching at Alonzo Secondary School for 12 years, it has been hard for Muller to believe that he has participated in professional development events only twice. Muller explicated,

I have attended about two seminars. Just imagine, I have been here for about 12 years now, but I attended two seminars.

Rudi's case: Although she has been teaching at Alonzo Secondary School for 26 years, Rudi has been able to attend a seminar only once, and this seminar was conducted at her school. Rudi explicated, *There are a few seminars. I have told you that I have an experience of 26 years being a teacher, but you can ask me how many times I have attended these seminars; it is once. Yeah and it was done here at school, so they can be offered once a year.*

Simona's case: Simona has been teaching at Johari Secondary School for 25 years; however, she attended her first training in 2006 and since then, she has not had any other chances to do so. Simona professed,

Since I have been here for 25 years, I attended my first training in 2006 and I have attended none for biology.

Viola's case: Viola stated that the professional development opportunities were insufficient; she attended two trainings since she started her teaching at the researched school. In her own words, she indicated,

Up to now, I have attended two trainings. Trainings for teachers are very few, they are very few, and the last one we went to was in 2014 but [there has been] *no other training for me and for other teachers from that time.*

Most of the participants remarked that they were slightly involved in the professional development activities, and some did not participate in any. Evidently, while some participants were able to attend once or twice a year, due to its inconsistency, most teachers were not enthusiastic regarding the effectiveness of the professional development they had received. Most of them had been in the teaching profession for over 20 years and wished they would regularly receive more professional development options.

Perceptions of the quality of professional development

This is the second subtheme that arose from types of professional development opportunities science teacher receive. The sub-theme explains the views of teachers regarding the quality of professional development activities in their schools. Most of the participants had negative views about the quality of the professional development and the availability of the programs. According to participants, professional development is revealed as limited in supply and uneven in distribution. Participants remarked that the professional development activities are not offered equally to all science teachers.

This sub-theme explains participants' perceptions that are associated with the professional development programs offered to science teachers. Although the government provides seminars and workshops to teachers, not every teacher gets the opportunity to attend those professional development activities. Some teachers attend workshops or seminars more than others and this brings up questions on what criteria is used in selecting teachers to attend those activities. This theme is divided into three sub-subthemes which are (a) uneven/biased (b) Insufficient professional development (c) Lack of transfer and (d) Lack of incentives.

Uneven/biased

This sub sub-theme is divided into three sub-sub-subthemes (a) teacher popularity, and (b) taking turns. Teachers expressed that the provision of professional development is not even, but biased. It depends on how liked you are by the individuals who are planning the professional development activities and how well you perform on your teaching. Otherwise, one can wait for her/his turn to arrive but it may not come.

Teacher popularity

Simona's case: Simona made it clear that if an individual is popular, known to the Administration Officers, most likely she can have a chance of attending the professional development events. With her own words, Simona expounded,

> *We don't, we don't…we don't get such things* [professional development opportunities], *you have to become well popular to some other people, and then, you are allowed to attend…*

In order to attend the professional development activities, one has to be well-known by the school administrators. This is definitely unfair to unpopular teachers who did not receive these opportunities. This confirms that the professional development options for science teachers are distributed unfairly and inequitably and therefore, they are not reliable. This unfairness translates to a lack of opportunities for other teachers to improve their knowledge and skills in light of new instructional strategies and chances to apply changes to their teaching practices. The provision of professional development for science teachers at the government-funded schools should be provided equally to every teacher so that all teachers can benefit from these opportunities and have a chance to apply new strategies and practices in their classrooms.

Taking turns

Vivian's case: Some of the workshops are carried out in different phases. When that happens, an individual who attends the first phase has to complete all phases before others can attend the first phase. In other words, teachers have to wait for other instructors to complete their cycles before they can start their own turns. Unfortunately, a teacher like Vivian has been waiting for a long time and her turn has not arrived yet. She wonders why others go for their turns while she is still waiting for hers. Vivian stated,

> *They offer professional development options in all science subjects, even in biology, yes, but it is people going in turns. The nature of the workshops, they call it a workshop, is that, someone should attend three workshops progressively, let us say it is progressively. When you attend the first one, you should attend the second and the third. It takes 2 or 3 years to complete the courses so in our department about two or three teachers have gone to attend the workshop. I know about three teachers who have gone there. I asked, and also the other teacher asked why are we not going to those seminars or those workshops, and we are told that, this is phase two of the first one, so those who attended the first one should go to phase two, and last time, I think at the end of the year they went for phase three. So, this year I have not heard about the phase one beginning, so I do not know, we just wait for information to come to us.*

The findings revealed that the professional development option could be unpredictable. The participant waited for her turn to attend training sessions but unfortunately, it did not happen. Possibly, the teacher might have been given wrong information regarding the opportunities, or there could have been some kind of bias in that the chances might have been granted to teachers who were close to the school authorities or administration.

Insufficient PD

Out of 13 participants, 6 participants thought that professional development is insufficient. Most of them pointed out that the insufficiency of these opportunities is due to the lack of funds in the government.

Peter's case: A few workshops are offered and the number keeps going down. A teacher like Peter gets a chance to attend after 5 years, and this shows how scarce these opportunities are—as a result, Peter thinks they are not useful. Therefore, Peter expects more opportunities to be provided so as to help him in his teaching. Peter stated,

> *As time goes on, we find that these workshops decrease but we still have only a few. You see nowadays they are just decreasing, but I do not think if it can be helpful because we go after 5 years. I think they are supposed to be increasing so that we can benefit. Now because they are very few, we can go for about 5 years and you find that there are new methods of teaching but no seminar that you have attended. The last seminar I attended was 8 years ago, in 2008 and the problem comes from the government, yeah, I think there may be economical issues and that is why they reduced those seminars.*

Leila's case: Leila thinks the professional development options are not enough and the chances of attending are very little. Leila explained, *Since I have been here, I attended workshops twice…but seminars* [there] *is*[a] *probability*, *yeah* [there] *is* [a] *probability. I do not know if they do not want to offer* [them], *I think at this economic crisis, seminars are not there, workshops are there, you can attend. But, I don't think that it is enough.*

Muller's case: Teachers face challenges related to the provision of professional development. The opportunities are not sufficient and therefore, teachers do not get a chance to improve their teaching practices. Muller understands the importance of staying informed especially when dealing with science subjects; however, due to lack of funds, the professional development becomes scarce. Muller explained,

I do not know what I can say; it is difficult to get the seminars due to economic factors. Learning process of science normally involves updating every now and then and if there are some changes. For example in the syllabus, we must be provided [with] *the seminar on how to teach or conduct the learning process in the classrooms. But the government can provide the new syllabus without teaching or without training the teacher on how to apply the new syllabus so, it is difficult due to the lack of some seminars. When you ask about the seminars, the government says there is no money for conducting the seminar for teachers; yeah, we face this problem.*

Rubi's case: The trainers are few and the same trainers need to conduct training for teachers from other schools. As a result, some teachers get to attend professional development once in 3 years. Rubi testified, *I told you, even in three years, it would be once because there are so many schools and these trainers are very few.*

Sydney's case: The professional development opportunities required money and their insufficiency makes it difficult to offer the options regularly. Sydney believes that if these opportunities were sufficient, they would be useful to teachers. Sydney remarked,

The professional development opportunities are not enough because those are limited with money, because when you conduct workshops money is needed, yeah it needs money and that is why I am saying that they are not enough. We need more…if they give us such chances frequently, they will help a lot.

Viola's cases: The trainings that intend to help teachers develop their abilities are not sufficient as a result; only two teachers are selected to attend and others do not get those chances. Viola explained,

So, they are very few. Not every science teacher in our department attends, two of us go. We are six teachers in the chemistry department but only two teachers go for those trainings. …the training that aims to build/raise the capacity of the teachers are very few, they are few.

In addition, Viola is the only participant who stated that the professional development program she attended did not offer any support or follow up. So the teacher did not know where to get help when stuck and she could hardly practice what she had learned because she did not know how to proceed with the materials. She explained, *Also after that seminar, there was no follow up made by the facilitators. If I failed to apply what I had learned, there was no way to find any information to help me, so what would I do, who can I tell?*

As the participants indicated, unfortunately, the professional development opportunities are limited, if not relatively rare. Training was provided through workshops and seminars; however, these options were not offered regularly and were not on-going, and funds seemed to be one of the major challenges that hampered the provision of professional development opportunities that these science teachers needed. In addition, there was no follow up or support after the seminar and teacher did not know how to use the materials she had learned.

Lack of transfer

Some of the participants who attended seminars acknowledged that when they go back to their classroom, they are not able to apply the lessons they learned in the seminar. Teaching resources are not readily available in their workstations and this challenge hinders them from applying the learning. In addition, the pressure that teachers get regarding covering everything from the syllabus makes them focus more on curriculum rather than delivering effective learning.

Muller's case: Lack of teaching resources prevents Muller from applying the lessons learned in the seminar in his classroom. As a result, he thinks that the learning activities are not useful. In his words, he explained,

> *Of course, there is no gain. In the seminar, I learnt how to teach, and it was good but when you come to* [the] *teaching process in the classroom, there is lack of facilities; it cannot enable you to teach how you have learnt from the seminar. Therefore, it did not*

help me. When you come to school, you do not have facilities to perform the lesson learned there.

Rubi's case: Teachers are stressed over completing the syllabus. Consequently, instead of applying the topics they learned during the seminar, in their classrooms teachers get concerned about falling behind due to shortage of time, so they regard the transfer of learning as a difficult task. The absence of instruments and a large number of students are also some of the factors that hinder the transfer of learning. Rubi remarked,

I cannot apply the material I learned because I am required to finish the syllabus, and the time is limited. It is difficult to apply it. If there were maybe 20 students…yes, then you can apply very happily, but also unavailability of instrument contributes. After the seminar, you go back to school, you find so many students in the class, and what are you going to do? To apply the learned lessons is hard. You see, I enjoyed when I was in the seminar, then I would like also to make the students enjoy as I have enjoyed, but how?

Participants who were able to take part in the professional development events declared that they could not apply their learning experiences in their classrooms, because the lessons they learned in the training required them to use tools. Equally, in order to apply these lessons they learned in the classroom, equipment was needed to implement what they had learned. However, when the teachers returned to their classrooms, there were no teaching resources. Thus, the lessons were not useful as they could not be incorporated into their practices. Therefore, most of the professional development activities did not meet the level necessary for producing powerful impacts on the teachers' practices as well as the students' learning.

Lack of incentives: There are hardly incentives in the seminar that are offered to teachers. As a result, these activities are not attractive to teachers. For example, teachers can attend the seminars the whole day and are not provided with food. As a result, it discourages them from attending these opportunities. Teachers who get the opportunities to attend seminars and workshops are willing to conduct professional development activities in their school for those who were not able to attend. However, funds are also a challenge in that the teachers who want to prepare the seminars or workshops do not receive any kind of incentives in terms of financial support to initiate the workshops or seminars, so at times, they fail to properly prepare for these events.

Rubi's case: There is no food at the seminars and financial support is unavailable. Rubi expounded,

> *When we go to these seminars, you stay there the whole day long without eating. So, a few teachers would be there to listen, but even these supervisors who want us to attend those seminars, they are not even paid also or if they are paid, it is very little.*

Albert's case: Even small incentives such as a cup of tea or a glass of juice are not available at the seminars. In addition, even those who wish to conduct the seminars are not supported financially for their time that they are willing to put aside for seminar preparations. Albert remarked,

> *I mean that they don't want to provide tea, when they do the seminar, so, you may find that people attend but they never get nothing, even tea, yeah, no tea will be there, no tea, no juice that is a challenge. Even those who provide the seminars need to have time to*

prepare themselves, in order to provide the seminar. So, for that time, who will pay the cost?

Participants revealed that they were not provided with any incentives in the professional development programs, and this decreased their motivational level. Even though they attended the sessions, they were not motivated to participate because at the seminar and workshops there were not any refreshments or monetary incentives which could help them such as bus fare and/or accommodation if needed. In short, the lack of funds was the major challenge that played a key role in offering incentives to teachers to be involved in professional development activities. Although the quality of the professional development offered cannot be measured by the teachers' participation, teachers may not be encouraged to participate in the first place especially if they are sitting for the whole training session without being given even a drink.

Science teachers were self-directed in individually seeking PD through both higher and continuing education.

This is the second theme which answers the questions regarding the kinds of professional development opportunities that science teachers receive. This study discovered that apart from the government professional development programs, participants find other means to learn in order to advance themselves professionally and personally. This theme is divided into a subtheme named *Self-directed programs.* The section that follows will explain this subtheme in more detail.

Self-directed programs

This sub-theme discusses the self-directed learning activities the participants undertook to further their education. The participants made decisions to return to school to obtain their bachelor's degrees and/or enroll in web-based courses. These participants did not receive any assistance from the government; they had to pay out of their own pockets to attend college to earn their degrees and certificates for short computer course.

Three of the participants claimed that they paid for themselves to further their education; two participants earned bachelor's degrees and one participant completed computer courses.

Theodora's case: After teaching with a diploma for a long time, Theodora decided to further her education by attending classes to obtain her bachelor's degree. According to her, government support was not available to assist her in paying for her classes. She made it through by her own efforts until she received her degree. Theodora explained,

> *Individuals are struggling. For example I started my diploma and later on I joined the University while within the teaching profession but I had to pay for myself… I started the teaching profession with a diploma, and individuals struggle to meet the requirements in education by themselves and the government does not support you, you have to struggle, go to school, you only request release from your duty to attend classes... I now have a degree in biology and chemistry; it is a bachelor of science in Education but my major subject is biology.*

Sydney's case: Sydney taught at Imani Secondary school for 20 years while holding a diploma. Sydney recognized the importance of self-advancing and decided to return to school to acquire a degree. It was possible for her to obtain the degree and she is now applying it at her workplace. Sydney explained,

> *I used my diploma for teaching for more than 20 years without taking my degree course but later to advance myself, I joined Open University of Tanzania and I studied* [for a] *Bachelor of Education in Chemistry, it is called BED Chemistry. From there, I got my degree and I am using it.*

Rosanna's case: Although she knew the significance of improving oneself personally and professionally, Rosanna has not participated in any professional development activities. She values her profession and for that reason, she made a decision to continue with her studies to attain a bachelor's degree. She earned her degree by paying tuition out-of-pocket. Rosanna expounded,

> *There is no professional development brought to my school by my government. Only on my own efforts because I like my profession, as I can study from the Internet. I became a science teacher for about 9 years holding only a diploma but I continued furthering my education and I have my degree now and I'm still teaching.*

Simona's case: Simona's wish was to develop computer skills and she did so by enrolling herself in the course. She did not get any type of assistance from her school, so she had to finance her own computer technology schooling. Her dream came true when she completed her schooling successfully. Simona remarked, *I've got this* [professional advancement] *through my own efforts. For example I started learning* [about the] *computer myself. I struggled on my own and then I bought my own computer. Then from there, I started learning on my own, on my own expenses then last year it was my first time to get a chance to learn Information Communication Technology (ICT) more. So, I learnt* [about the] *computer on my own, no one took me to the computer course, and no one encouraged me to go to* [the] *computer course but myself…I know by using* [the] *computer I can learn a lot of things.*

As some participants mentioned, they recognized the need to advance their career by obtaining a University degree so they went beyond the call of duty to continue their education and earn their bachelor's degrees. One participant mentioned that she recognized that technology is constantly changing so enrolling in continuing education not only gave her the tools she needed to incorporate technology in the classroom but also allowed her to acquire knowledge which helps her apply the lessons learned into her daily life. These opportunities were available for them but their schools were not financially supportive; they helped in other ways for instance, allowing them to take off days and take a leave from school. These teachers were satisfied with the knowledge, skills, and other attributes they acquired as a result of their higher education experience. These teachers did not only add value to their lives, but also to the lives of their students and peers. They are not the only ones benefiting from their accomplishments, but students, peers, and their schools as a whole gain by having knowledgeable teachers. It is clear that the government cannot afford to help every teacher to further their education, but it should strive to provide bonuses or remuneration increases as an incentive for them to further their education.

The following section seeks to answer research question 2 regarding the instructional methods science teachers us. The themes, sub-themes and sub-subthemes which emerged from the data analysis will be explained.

RQ: What methods do Tanzanian secondary school teachers use to teach science to their students?

Theme: Using teacher-focused, traditional methods to teach science

The first theme of the science teaching methods is using teacher-focused, traditional methods to teach science. Participants asserted that they use theoretical aspects in science teaching by using a teacher-focused method due to science curriculum being over-loaded with content. As a result, they teach didactically and theoretically and hardly perform experiments and practical activities. Most teachers expressed that they teach science subjects by using the talk chalk method, which translates to rote learning. This theme is discussed in the sub-theme of instructional strategies, which is also divided into two sub-subthemes (i) lecture and (ii) demonstration.

Table 10. Instructional Methods Science Teachers Use

RQ and how it is answered	Themes	Sub-themes

What methods do Tanzanian secondary school teachers use to teach science to their students?	Teachers use teacher-focused, traditional methods to teach science.	• Instructional Strategies
		  o Lecture
		  o Demonstration
		• Motives for choosing didactic-focused method
		  o Non-instructional strategies lessons are taught in seminars
		    ✓ Grading exams
		    ✓ Syllabus modification and tough science topics
		    ✓ Special needs' students
		    ✓ Using improvised tools

	Governmental resources, insufficient professional development, and curriculum demands inhibit teachers from using modern teaching approaches.	• Lack of contemporary instructional delivery methods due to the limitations of tangible instructional materials
		  o Lack of teaching resources
		  o Inadequate labs and tools
		• Conflict between government policy and education practices
		  o Less consideration of real classroom conditions
		    ✓ Syllabus length
		    ✓ Over-emphasis on the National exam

Instructional Strategies

The current Tanzanian science curriculum advocates a student-centered approach whereby students are actively engaged in both the classrooms and laboratories. All participants claimed that a student-centered approach is best when teaching science subjects as it builds a strong knowledge foundation and develops learning skills for students as they are engaged in hand-on-activities. However, teachers experienced that teaching of science with limited laboratory resources is very difficult and time consuming thereby hindering the teachers from involving students in hands-on activities.

Additionally, the large number of students and high pressure of completing the syllabus force teachers to mainly use a teacher-centered approach. All participants acknowledged that this approach is disadvantageous in teaching and learning because it makes the students passive and the only person who dominates the lesson is the teacher. This method is the teacher's first option whereby it forces teachers to lecture and write notes on the board and expect students to copy and memorize the abstract concepts taught. As a result, this kind of instruction does not promote an understanding of the taught or imparted concepts.

Lecture:

Albert's case: Albert acknowledged that teachers are not permitted to use the lecture method to teach science; however, the large number of students and lack of teaching materials forces him to use the lecture method. Albert stated,

> *We are not allowed to lecture, but we just use it anyway to teach the lesson and the way that we use to teach the lesson, of course we call it teachers-centered, yeah, I'm saying that because a teacher should be everything, and that is because of a number of students we have and also the materials*

Alpha's case: Three-quarters of instruction is performed using the lecture method due to lack of laboratory equipment. Alpha explained,

> *…because of lack of chemicals and apparatus, we do not have them fully, we have* [them] *just partially. …almost we teach three-quarters of the lessons theoretically. Now, three-*

quarters of the subjects we teach using lectures [are] *due to this reason behind…because of the lack of apparatus.*

Vivian's case: Vivian noticed that when she delivers the instruction by means of a lecture, some students do not pay full attention and when asked question, they are incapable of producing answers. On the other hand, using a student-centered approach requires time and sufficient teaching resources which teachers do not have control over. The option left is lecture-based instruction as Vivian explained:

> *Sometimes, I use lecture but at the end of class, if you ask questions you will find only a few students are able to answer you. They don't follow, so many of them don't follow…but then,*[the] *student-centered approach is time-consuming and it requires materials, it requires learners to have self-motivation for them to go find some information which you* [the teacher] *want. So, it becomes difficult because you find some learners do not want that, they want you to come, lecture and go, do not ask them questions, just give them assignments, so it is difficult.*

Muller's case: Muller writes on the board, and students copy. Thereafter, students memorize and tackle questions assigned by the teacher. In his own words, Muller remarked,

> *I teach them and I write notes on the black boards and they copy the notes. They memorize by giving them notes, and after copying, I give them the exercise.*

Peter's case: With the large number of students, teachers find it easier to teach using the lecture method and according to Peter, that is how teaching in most schools functions. Peter stated,

> *In most schools now, we are using* [the] *teacher-centered method because for teachers to make groups in small rooms with* [a] *very large number of student is difficult. So, most schools I think the best method is* [the] *teacher-centered method. They use* [the] *lecture method because we have very large group of students.*

Rubi's case: Mostly, teachers taught science subjects theoretically, as Rubi declared. Teachers utilized the lecture method in teaching and this was done speedily with an aim of completing syllabi rather than engaging students in learning with a goal of assisting students to understand the science concepts effectively. Although she is aware that teachers are not allowed to use the lecture method, Rubi cannot avoid it because she must complete the syllabus; due to the large number of students, giving a lecture remains as the main choice in terms of delivery of instruction. Rubi, in her own words, explained,

> *We normally use lectures or write notes on the board. If you want to practice (experimentally), it is very difficult. So, because you want to finish the syllabus and students are so many, even if you want to put them into groups so that they can investigate and arrive at a conclusion, you will finish the period without coming to an answer. Therefore, I use lecture though we are not actually supposed to use it. We are blamed if we do not finish the syllabus. Now we are in between there, we are required to finish the syllabus, so that is why in order to be on the safe side, we use lecture by talking, talking, and writing so that we finish the syllabus. The time is limited and the number of students is big. You are a good teacher if you have finished the syllabus.*

Simona's case: The large number of students seemed to be a huge challenge for teachers. Simona mentioned that due to the number of students, she chose to use a teacher-centered approach and avoided the experiments aspect of the lesson. According to her, practical and thoughtful activities require preparation time; however, a teacher like Simona felt it was not worth it to invest her time in the preparation of experiments because her salary cannot compensate the work it requires. In other words, she worked more and earned less:

> *We have faced a problem recent due to the big number of students taking chemistry, particularly. In teaching practical, there are times when I have to opt teaching theory. This is because there is a problem of preparation of the practical and the time is not there. When it comes to the question of "why should I waste this time" that means I have to prepare practical on my own time, and then after preparation of the practical, I have to impose more time for preparing a lot of logistics before going to the class. Now, all this time, who is going to pay me for all this? …very low wage, why should I do it? Then I decide to go to the theory.*

Simona's case: Simona continued explaining that her work is heavy and no one pays attention to it in terms of compensation. As a result, she taught using a lecture, and instead of spending time on her students in the classroom, she invested time in the tutoring job that she performed outside of her school. This side-tutoring job provides her money that helped fulfill her life's goals. Simona professed,

> *Why should you impose more time while someone is not thinking about the heavy duty that you are doing? … Therefore, I decide to teach theoretically and therefore, most of*

the science subjects we teach theoretically not in a practical way. People are not ready to do it; people are not ready to do it. What am I going to receive from here…suppose I teach them theoretically, I then, I force them to understand. I force them to understand rather than imposing my time, I don't get anything, I get low wage, this time I can use it for producing something which will assist me in my life. That is why people, even myself I have sometimes decided to teach, we are supposed to teach practically, but I do it theoretically.

Simona avoided experiments because of the time and activities required to prepare for them. She affirmed,

There are times when I must use experiments but I use lecture method because it does not require me to do any preparation. (In terms of lectures) I know each and everything, I know what I'm going to do, I know everything but practical, I should go to the laboratory, I should prepare the solution, I should arrange this way, and then I know this group should come, and then I should stay here, start teaching, solving each and everything….

Sydney's case: According to Sydney, student-centered approach is time consuming and may result in preventing her from finishing the syllabus. In order to move speedily, she used teacher-centered approach whereby she covers a lot of material at once and move on to the next topics. Sydney explained,

Yeah, the students centered method needs time, if you are not careful, you might not finish the syllabus. You will not cover the syllabus because it consumes time; it is time *consuming, something different from teacher centered method. With teacher centered method you can move very fast because you just cover, cover, cover and go ahead, yeah. Because with student centered method you have to assess also to see if they did the correct thing. You are supposed to test them and such kind of evaluation, you are supposed to do assessment and that is time consuming.*

Theodora's case: Although Theodora used lecture method, she made sure that it was modified in a sense that she engaged students in the discussion. She maintained,

We first use lecture method to some of the topics or subject matter and although we use lecture method but we use modified lecture methods because students are very much involved in our discussions.

According to Theodora, the schedule may indicate that a teacher is required to have 16 periods which translates that for the whole week the teacher goes to class 16 times. To implement a student-centered approach becomes a challenge because it required time for the teacher to prepare teaching materials and class activities. Time being an issue, teachers like Theodora find it difficult to implement student-centered approach in their classrooms. She affirmed,

You know, a teacher might be having 16 periods which are allocated on the timetable, and she or he has to prepare all of this teaching material or instructions, she or he has to prepare also practical or activities concerning such lessons or such subject matters she is teaching or he is teaching, then in order to implement well a student centered method, the teacher should be very much involved in planning, collecting teaching materials and *resources, so that the students will use them. So, that is the obstacle here, where the teachers do not need or do not use their time to prepare this or to implement this student centered method, because of time, so time is one of the factor.*

According to the participants' remarks, most of them use lectures as their first choice when teaching. One of the main reasons these teachers chose to use lectures is that they are not time consuming. Lectures allowed teachers to provide information to a large number of students, and teachers were able to cover a large amount of material quickly as to meet the curriculum requirements. Thus, lectures became the easiest and quickest teaching methods for science teachers; however, lectures gave fewer opportunities for students to develop problem-solving skills, and teachers did not have enough time to provide feedback to their students. This teaching method promoted a teacher-centered atmosphere instead of a student-centered atmosphere where students are actively engaged in the learning process instead of merely being passive.

After analyzing documents, this study discovered that the examination questions emphasized the memorization of definitions and facts. Although the secondary science curriculum promotes a student-centered approach, the teachers still focus on instructing didactically. Basically, teachers were assessing students' competency in defining facts and writing correct formulas. In spite of the fact that the current curriculum is designated for teachers to use the student-centered approach, the researched secondary schools displayed that lectures are the main teaching strategies for science subjects. The following sections illustrate the classroom activities, specifically pedagogical practices, in the science classrooms observed.

On the morning of July 28th, I conducted a classroom observation in a physics classroom at Johari Secondary School. The class was designed for form two students. A few minutes before class began, the physics teacher and I entered the class, and all of the students stood up and greeted us. We greeted the students, and they were asked to sit down. Then, since the class was very full and there were not enough chairs for all of the students, the teacher asked one of the students to give me his chair. Before she started the lesson, she asked me to introduce myself, and I did as the teacher requested. This is how the class was conducted:

Students: Good morning, madams

Teacher and Researcher: Good morning, students. How are you?

Students: We are fine, thank you, madams.

Teacher: Please take a seat.

Students: Thank you, madam.

Researcher: My name is… I am a student at the University of… I thank the teacher and you all for giving me the opportunity to sit in the classroom and learn physics with you.

Teacher and Students: You are very welcome, madam.

Teacher: Student, can you give madam your chair, so she can seat?

I walked to the back, and one of the students there gave me his chair. I wanted to seat at the back so that I could see everyone and observe carefully and precisely. All of the students sat down, and the teacher stood at the very front. The class had a blackboard and chalk, and the teacher wrote the heading "Distance, Speed and Time" on the blackboard. Then, the teacher started asking questions.

Teacher: Today, we will continue with our previous lesson "Forces and Motion." Who can give a definition of speed?

Student: Speed is distance travelled per unit of time.

Teacher: Another student should come to the front and write the formula on the board.

Student: Speed is distance divide by time.

Teacher: Students, is there any correction to that formula on the board?

Students: No correction, madam.

Teacher: I believe everyone has notes from the last lecture. All formulas were given and examples of calculations. (The teacher continued the lesson by explaining distance and time and their formulas).

Then, the teacher wrote two questions regarding speed that involved calculations and asked students to solve the equation. She requested for students to give their answers to the calculations, and their answers were correct. Before the class ended, she wrote notes on the board, and some students were copying them. I observed that some students were not writing down these notes as required by the teacher, so when she started walking towards a few students who were seated in the front row, the teacher said *"I see some students are not writing notes, you are supposed to take notes."*

This physics lesson was conducted over the course of one period, which lasted 40 minutes, and I observed that the teacher focused on writing down formulas and definitions of terms instead of putting the greater emphasis on students' understanding of the scientific concepts. In addition, the interaction between the teacher and students and that of students-to-students was weak. Students remained quiet until the time the teacher selected or pointed out one of them to answer a question.

Overall, based on most of the participants' accounts and the observations, teachers were applying teacher-centered instructional strategies such as lectures where the students listened to the teacher and copied notes. Therefore, teachers mostly taught the theoretical past of the subject not using a student-centered instructional approach which confirmed participants' remarks that a lecture was the instructional method teachers most commonly used to teach science.

Demonstration

This study revealed that at times, teachers employed demonstration as a teaching strategy due to lack of laboratory equipment. According to the participants, there were very limited resources to conduct experiments in the laboratories and to perform hands-on activities in the classrooms in comparison to the number of students they have. As a result, teachers designed 'demonstrations' to facilitate teaching and learning in a manner that gives students an opportunity to make observations while the teacher is conducting the demonstrations. Out of 13 participants, seven of them thought that demonstration is valuable in aiding the learning of science and it is a good method in teaching and learning especially when there is lack of laboratory resources.

Albert's case: There are no teaching materials, even learning materials such as books; therefore, teachers used diagrams to demonstrate concepts to students. Albert explained,

> *…we demonstrate through the diagram because we have no materials, we have no books; that is the difficulty. You may have a chance of telling the student that, "Do this assignment,*

but what you hear from the student, they will tell you, 'Sir, we don't have books,' how we can practice?

Alpha's case: As a way of demonstration, Alpha made use of graphs, charts, and photos to validate concepts because of the unavailability of actual equipment in the laboratory. He pointed out,

I just use photographs, graphs, charts, pictures, other drawings out there, instead of real equipment. We commonly use those but not 'real' practical. 'Real' practical, we fail to do due to the lack of chemicals and apparatus.

Muller's case: According to Muller, although demonstration is not as effective as conducting a practical in a fully equipped laboratory, he felt it was better to illustrate theories to students than not to do so at all. He drew the diagrams on the board and that process did not require any chemicals. In his own words, Muller expounded,

I can draw the diagrams on the blackboards, even the simple demonstration that does not involved much chemicals, we can do it in the classroom but it is not so very attractive for students' training, compared to if the laboratory is well equipped, it can be the attractive for the students, it can attract students' training.

Peter's case: The issues of completing the syllabus and having a large number of students are of great concern for teachers like Peter. To make it simple and quick, Peter used demonstration to show students how to conduct experiments. Peter stated that,

According to the number of students, a method such as role-play, if you tend to use it, you will not finish the syllabus. This is because the way of arranging students in the class *will take the time, because they are so many [students], so it is difficult to finish the syllabus. Therefore, we try to reduce the method, to simplify them, some topics that do not need such a method; we will select another method that can go quickly. For instance, there is a way of demonstrating that also I can use. I can use demonstration, so students come together and be around the table, now the teacher shows demonstration and then students go back to their groups and then they bring apparatus and then they do as teacher did.*

Rubi's case: To conduct the actual experiment in the laboratory would require much time and Rubi is concerned that the whole class period will be used for a practical, which to her seems to be a waste of time as she could be using that time to teach other topics. She does not let students do the experiment because they will take longer, so in turn, she demonstrates while students observe. Rudi declared,

If I allow, for example to do an experiment, do you think what time I would use for each group to arrive at a conclusion and then we should summarize together. Conducting an experiment about a topic that I can take maybe five minutes, I will take the whole period. Because of the circumstances, I normally would say, "you students understand that density is equal to mass over volume, this can be done this and this and that and that, (demonstrating) than letting them do the experiment on their own. It is very hard to do that because it will take so many periods.

Simona's case: According to Simona, experiment work was absent due to lack of time for preparation. Basically, she shows students how to conduct certain experiments and then ask students to apply what they would have observed. She explained,

> *In terms of practical, the practical work is not there, I just teach or I just demonstrate rather than preparing practical for 63 students. Why should I do so? I just demonstrate myself, you observe, you see what I have done, and then take the consideration I apply the same to all other topics.*

Simona's case: Time and lack of equipment are a huge factor in the preparation of activities for experiments. As a result, she minimized her time by conducting short demonstrations while student watch her. She expounded,

> *They [students] do not do it. I do (demonstrate) it myself and in doing so myself I just minimize the time. I minimize the time but for those who are observing it, they can see. That is why I say instead of giving them [experiment] I do it myself. 'Take this, do it and do it yourself', that is what I'm trying to avoid because I don't have time to prepare enough solution for all these students, enough equipment for all these students, I just demonstrate myself and they can capture the knowledge, that's how I do it.*

On July 29th, I visited Alonzo Secondary School in an effort to observe a physics classroom. The class was intended for form one and it was also overcrowded, with about 66 students. The physical classroom was small and possibly could fit only 25 to 30 students. Again, there was no space for anyone to move around, and some students were standing up for the whole class period. The main topic was measuring the mass of an object. There was only one beam balance available for 66 students, so the teacher asked all students to move forward and pay close attention as he wanted to show students how to use the beam balance. The teacher started demonstrating how to measure mass, and students were observing closely. The teacher was the only one speaking, and so, the interaction between the teacher and students was very limited. When he finished demonstrating, he asked for three volunteers to go to the front table and perform the same experiment that he had just finished. The goal of this exercise was for the three student volunteers to demonstrate to the other students how to measure mass while the other students continued to be observers of the activity.

Demonstrating a concept to a large group of students within two class periods, which lasted 80 minutes, was not easy. After demonstrating, the teacher drew a diagram on the blackboard for students to copy, and he insisted that students should label the diagram properly. The last 15 minutes of class, the teacher wrote a question on the board which read “Describe the procedures you have learned on how to use a beam balance to measure mass”? Students started writing down their answers. Before students finished writing, the class period was over, and the students left.

The teacher and I walked together outside and had an informal conversation regarding the lesson. The teacher professed that the lack of material in the laboratory forced him to use a demonstration technique in the classroom. For instance, there was only one beam balance, and the number of students was too large to even see the concept that was being demonstrated. So, the teacher identified the overcrowded classrooms as one of the challenges he had faced teaching science at Alonzo Secondary School. The teacher stated, *With one beam balance in the lab, it would not be possible to set up a successful experiment for each of the students. And, truly, teaching in a school setting, where there is a lack of teaching resources, is very difficult not only for me as a teacher, but also for students, because they may not understand the concept by just watching. They must do it themselves. They must perform the experiments.*

Due to limited laboratory equipment, the teacher used demonstrations in his teaching of physics. In a demonstration lesson, the teachers showed students an experiment but failed to give a chance to students to practice what they had observed because of shortage of equipment. Even though there was an inadequate amount of laboratory equipment in the school, the teacher strived to use the only tool available to ensure that students grasped an understanding of measuring mass using a beam balance. This lesson indicated that the teaching and learning methods that the teacher used depended on the availability of teaching resources available in a school. On the other hand, the demonstration lesson that I observed was not effective because science learning is an activity that students do and not something that is done for them.

Considering the small space and the large number of students in the classroom, some of the students could not really focus on the demonstration activity. Calling three students to the front to emulate the demonstration to other students does not mean that every student in class understood the activity. However, beside the three students who volunteered to emulate the experiment, all of the other students in class did not have a chance to conduct such an experiment individually or even in groups to practice what they had just observed and learned from the teacher.

Governmental resources, insufficient professional development, and curriculum demands inhibit teachers from using modern teaching approaches.

The fourth theme still answers the research questions regarding the teaching methods that science teachers use. This theme is divided into three sub-themes which are (a) motives for choosing teacher-centered, traditional methods; (b) lack of contemporary instructional delivery methods due to the limitations of tangible instructional materials; and (c) conflict between government policy and education practices.

Motives for choosing didactic-focused methods

The study discovered that teachers faced many challenges that hindered them from implementing the instruction of science subjects effectively. Such factors pushed teachers to use traditional methods of teaching such as lectures. The large number of students, inadequacy of laboratory equipment, and the stress of completing the syllabus have been identified as factors that contribute to teaching science didactically. The teaching environment is unfavorable due to lack of teaching materials and this insufficiency forces the teacher to teach all aspects of science theoretically and escape the practical sessions. Lack of relevant teaching and learning materials such as insufficient laboratories, shortage of laboratory tools, lack of books in the school libraries, and lack of space in the classroom due to large number of students all cause teachers to opt for the lecture teaching method.

The current overloaded syllabus is another challenge that makes it difficult for teachers to use a student-centered approach as emphasized in the curriculum. Most teachers felt that limited time does not permit them to teach using a student-centered approach because such a method demands time for lesson planning and implementation in classroom. Therefore, teachers mostly used lecture-based teaching that is linked with didactic, traditional, and teacher-centered approaches even though they acknowledged that this teaching method is not recommended in teaching science. The chalk and talk method served as the cheapest and easiest option for science teaching.

Non-instructional strategies lessons are taught in professional development events

This is a sub-subtheme of the motives for choosing didactic-focused methods. This sub-subtheme gives details regarding the lessons that teachers learn as a result of attending the professional development activities. It focuses on the following sub-sub-subthemes (a) grading exams, (b) syllabus modification and tough science topics, (c) special needs' students, and (d) improvised tools.

Grading exams

Participants remarked that the seminar they attended gave them a chance to learn how to grade their students' examination papers.

Viola's case: Learning how to grade is what Viola learned at the seminar. With her own words, she stated,

> *The training that we attend are those involving how to mark examinations. They are seminar for how to make the examination/national examination.*

Vivian's case: The seminars did not only allow Vivian to learn how to grade but also taught her how to formulate examination questions and how students should answer those questions. Vivian expounded,

> *The seminars provide the opportunity for us teachers, and when it comes to marking the examinations, national examinations, everyone is given an opportunity so you go there because marking also is improving us; we learn how we can ask questions and how questions should be answered in exams, so it is an opportunity*

Some of the participants who participated in the seminar indicated that they learned how to grade students' final examinations. One participant learned how to ask students questions and how students should respond to the questions. Although it was beneficial for teachers to improve their grading skills and sharpen their questioning skills, I considered that this kind of professional development learning did not meet the needs for science teachers to expand their knowledge of science content and pedagogy. Professional development would be more relevant when it helps teachers develop and apply the knowledge and skills necessary to help students learn in the classroom. Therefore, this professional development would not help science teachers largely because it did not incorporate knowledge of science or learning of instructional methods to help teachers understand the concepts of the subject matter in order to improve their practices.

Syllabus modification and tough science topics

Participants said that there were some topics that were difficult for them to teach. Therefore, when they attended seminars or workshops, they had opportunities to discuss and tackle those topics with other teachers. Simply put, these activities served as shared experiences and teaching matters to help solve teaching challenges. In addition, teachers had discussions regarding curriculum modification whereby they contributed their views to stakeholders in order to produce a well-organized curriculum.

Peter's case: Teachers exchanged their teaching experiences and handled complex science topics at the workshops. Peter remarked,

> *At the workshops, we discuss about the syllabus, and about hard topics. We have to mention topics that have been problem in teaching then we try to exchange experience. We discuss the syllabus, and we have to discuss topics, which are supposed to be in form two or in form three so that we can give our advice to the curriculum shareholders. Therefore, we get to put a syllabus that can be covered in the time.*

Teachers review the syllabus and determine the order in which topics should be arranged in the curriculum. According to Peter, some of the seminars cover mostly the assessment of the curriculum. As he mentioned,

> *In that seminar, we passed through syllabus, then we went over syllabus and then topics, arrangement of topics from A-level to from O-level, discuss which topics are supposed to be in form one, ranging from simple to difficult. Therefore, we just discuss about the syllabus, yeah, about curriculum.*

Sydney's case: Teachers come together in the seminar to solve issues related to their teaching practices. Sydney mentioned that topics that teachers find challenging to teachers are brought in for discussion and they find ways to solve them. In addition, syllabus modification forces teachers to think about and create new teaching and learning materials for their subjects. Sydney explained,

> *In case there is an area in science, for example, an area that teachers find it difficult then it's where they can seat discuss in the seminars and solve it together. Therefore, in case there is difficult area which disturbs teachers during teaching it is when we discuss it. The syllabus also changes, when the syllabus changes it means that there are new things, which are introduced there so people should also be required to produce materials, new materials such as books and other.*

The findings of this study revealed that when participating in the seminars and workshops teachers had an opportunity to discuss the syllabus changes and talked about how to handle difficult topics that teachers found difficult in their classrooms. Even though it was important to incorporate the curriculum issues and difficult topics in the trainings, it was equally critical for teachers to learn science content and engage in effective instructional methods so as to develop a sense of how to implement new practices in their classrooms. Possibly, putting an emphasis on learning the scientific concepts and modern teaching methods in the training may improve the skills of secondary school teachers in terms of providing quality science instruction. Conversely, discussing syllabus modification may not have a greater impact on enhancing teacher practices, but if the professional development integrated the 21st century science practices such as inquiry-based approach, then this may have persuaded teachers to change their skills and daily classroom procedures and in turn, student learning.

Special needs students

Olympia Secondary School has special needs students, but for a long time, these students were not able to learn science subjects, because there were no teaching aids, and also, teachers did not really know how to instruct students with special needs. Recently, the school started providing teaching and learning aids for students and the teachers responsible for special needs students were offered training to assist them in teaching special needs students.

Leila's case: One of the special needs teachers was provided with training to effectively teach science subjects to special needs students. Leila shared her experience about the training she received. She indicated,

> *Here in school, we have blind students. For many years, they have not been taught science subjects, but we started this year teaching science. So, we attended a seminar and learned how to teach them, these blind students, science, visual impaired students. So, I attended a seminar, and we were taught a lot on how to teach them by using teaching aids and how to make them participate in doing experiments and so on and on.*

One of the reasons for teachers to participate in the professional development is to learn how to teach special needs students. For many years, science teachers did not have enough experience to work with special needs' students. However, at the present time, teachers attended the training specifically to learn the instructional needs of these students. The participation in the training allowed the teacher to gain skills and knowledge needed to help the students with special needs who are learning science. This means the learning opportunities and access to education for students with special needs improved as the teacher prioritized education knowledge and facilities concerning students with special needs. This was confirmed when I observed a computer lab and saw a few students with special needs learning; I recognized that there were resources allocated for teachers to effectively meet and address these students' basic needs and learning styles.

Improvised Tools

When teachers lacked the actual equipment in the laboratories, they use locally available materials. According to teachers, improvisation is essential in teaching and learning science, especially where there is limited laboratory equipment. For this reason, teachers are offered professional development activities so that they learn how to use locally available tools to facilitate laboratory-learning activities.

Peter's case: According to Peter, many schools do not have sufficient laboratories, therefore they used improvised materials to substitute for the actual equipment. In that regard, in some of the workshops teachers attend, they experience learning related to the improvisation of laboratory equipment. Teachers get the opportunity to learn how to use the locally made materials in the absence of real laboratory equipment. Peter expounded,

> *At the workshop that we attended, we learned how to make teaching aids by using local materials. It was about teaching apparatuses. It was the improvisation. When there are not enough apparatuses, [a] teacher can use local materials. For example, we can use water bottles as eureka cans. In other seminars for physics teachers, we attended the laboratory to learn how to prepare experiments. Many schools do not have enough laboratories and*

apparatuses, so, and most teachers do not know how to use other apparatuses. Therefore, it was a good chance for most teachers to understand various apparatuses.

Muller's case: Instead of depending fully on the actual laboratory equipment, in the workshops, teacher learned how to form improvised materials to use them in the absence of real materials in the laboratories. According to Muller, teachers who lack apparatuses in their school laboratories had a chance to learn how to use locally available equipment. Muller indicated,

The workshop we attended, we were taught to make teaching aids, teaching aids by using local materials, and then, we presented there so that teachers without enough apparatuses, they can use local materials to prepare their apparatuses.

Simona's case: Simona's first training was about the improvisation of laboratory tools. Teachers who were not able to conduct experiments because of an inadequacy of equipment could learn how to make those tools if selected to attend the training. Simona was one of the teachers who had the experience of attending such an event. She asserted,

My first training was in 2006. I attended chemistry improvisation of apparatuses. If you have failed to carry out an experiment because you do not have let us say a beaker, then you can improvise. Training involved improvisation was the first time for chemistry. For biology, I have attended none, and lastly, I just got this one here.

Theodora's case: Theodora was one of the participants who experienced the training on how to create the improvisation tools. As she declared,

In the seminar, we are involved in how to prepare teaching materials by using locally available materials.

In workshops and seminars, teachers are taught how to use locally available materials in the absence of the actual equipment. This implies that in order to use the locally made materials, one should have enough knowledge on how to teach using such tools. The teacher could acquire the knowledge by attending seminars which provide improvisation-tool lessons. However, since not all of these teachers got the opportunity to attend the professional development activities, it may be difficult for the teachers who could not attend to learn such lessons. Thus, in a case in which there is a lack of laboratory equipment and the teacher has not been received training on how to use locally made tools for science, he/she might use the tool ineffectively or opt to lecture to avoid such issues completely.

Lack of contemporary instructional delivery methods due to the limitations of tangible instructional materials

This sub-theme is divided into two sub-subthemes, which are (a) lack of teaching resources and (b) inadequate labs and tools. These sub-subthemes involve the conditions that prevent teachers from using contemporary teaching methods in their classrooms, and they will be discussed below.

Lack of teaching resources

Participants in this study remarked that government funding for schools is inadequate, and thus, this challenge caused a negative effect in that there were insufficient resources for a large number of students. Participants indicated that there was a lack of government support in the provision of resources, laboratories and equipment, and facilities. The schools lacked well-equipped laboratories and had insufficient resources, such as modern textbooks, chemicals, and well-stocked libraries; the absence of these instructional tools contributed to the ineffective teaching of science. According to the participants, all these obstacles affect the manner in which they teach science subjects as they believed that the quality of instruction a teacher applies in the classroom essentially depends on the teaching and learning resources provided by the school.

Albert's case: Teachers expressed that science textbooks are not readily available, and the teacher can be the only person who owns a textbook. Most of the textbooks are out-of-date, and some of the schools' libraries are inadequately equipped with obsolete books. Albert stated,

> *… I mean the materials that we use to teach, for example, here, we do not have, we do not have a library for the students to use. So, the teacher is everything; the teacher has one copy of this book; so, the only one who knows is the teacher. So, if you go to the students and ask them to do exercises, they can speak the truth, "Sir, you are asking us to do exercises, but we have no books." Now, you can tell them that they can find these materials on the Internet, but they reply "We have no access; how can we do so?"*

Muller's case: The teacher has a textbook, but students have to share books, because there are not enough of them. As Muller mentioned,

> *I have the textbooks, but the textbooks are not enough for the students. So, the teacher has the textbook to prepare notes.*

Theodora's case: Teachers may need to travel in order to obtain the teaching material but there is no one to help cover the cost. It gets to a point where teachers want to buy teaching materials out of their own pockets just to fulfill students' learning needs however, teachers realize that it is not worth to take such an action. Therefore, they find ways to teach without the essential material and by any means, they ensure students understand their lessons. Theodora asserted,

> *Where you can attain those teaching materials, it may happen that a teacher must collect, when and where perhaps you need money to travel, no money is being provided by the government to schools so the teacher has to take his or her own money from his salary to collect teaching materials and the teacher sees that it is not worth for him or her, so she decides or he decides to do whatever he can so that the students will understand the lessons.*

According to participants, it was very challenging to effectively implement the instruction of science subjects due to the unavailability of teaching and learning resources, especially textbooks. Access to science textbooks was limited, and one text book could be shared by up to four students in the classroom. And, at times, the teachers might be the only person having a textbook. Most of the textbooks were out of date; some of the schools' libraries were inadequately equipped with out-of-date books. Lack of books for science teaching and learning is one of the major issues across the schools studied. The deficiency of modern textbooks and absence of books in libraries contributed to the ineffective teaching of science.

All these obstacles affect the manner in which science should be taught, because the quality of instruction a teacher applies in the classroom basically depends on the availability of teaching and learning resources. The critical scarcity of textbooks affected the teaching and learning of science, because teachers opted to read out applicable sections to students and write notes on the blackboard; this translated to rote learning. The provision of supporting teaching and learning materials, such as textbooks, is vital to the quality delivery of science education. The absence of these supporting materials negatively affected the quality of the teaching and learning of science. Therefore, textbooks are an essential tool for the teachers' work as they choose content and various activities for themselves and for students. Thus, textbooks have a crucial part to play as far as teaching and learning are concerned.

Inadequate labs and tools

Lack of resources for science teaching is a major issue across the schools studied. Teachers believed that the access to laboratories and availability of lab equipment play significant roles in the teaching of science subjects, because it allows students to learn and understand abstract concepts more effectively. However, while these teachers supported and wished to teach science through experiments and perform practical activities to improve students' understanding, they reported that their schools lacked necessary teaching resources, and there were inadequate laboratories for implementing laboratory activities.

Albert's case: Form I, form II and form III students do not have access to the laboratories until they reach form IV when it is time for them to prepare for their national examinations. Equally, form V students will wait until they get to form VI to use the laboratories. In other words, before students get to form IV and form VI, they barely get into the laboratories, because they will be occupied by the students who are about to take their national final examinations. Albert indicated,

> *…of course, we normally wait… wait, wait… for example, we have ordinary level students here, and we have the Advanced level students. A student will join form one (O'*

level), form two, form three. When he is in form four, he will be able to have laboratory access. The form five will continue, and when they are in form six, they will be able to have access in the laboratory. That is what we do.

Trying to equalize between students who are approaching the national examination and those who do not have to sit for the national examination until the near future, Albert indicated the importance of giving priority for using the lab to the students who are preparing for the examination. This is because students are required to conduct experiments in the examination to demonstrate their ability to integrate knowledge and theory into practice. As Albert avowed,

…*that is the problem. Now, you think, the form six students are going to have the national exam and have to do a practical exam, and in form four, they also have the NECTA examination, and they have to do the practical exam, but other students (forms I, II, III, and V) have no exams. So, which group should go to the laboratory?*

Vivian's case: There are not enough laboratories for all the classes; it gets to the point whereby teachers collide in the laboratories. There are a lot of students but extremely few laboratories, and at times, teachers avoid going to the lab, because they know the time is limited and other teachers are waiting for the same laboratories. A teacher, like Vivian, chooses a few topics that usually appear on the examination and reveals such topics to students so that they have an idea of how to conduct experiments on those particular topics in case they are on the examination. Vivian stated,

The labs are not enough, and sometimes, we collide. You want to go there to do your experiments with the students, and then, another teacher wants to do experiments at the *same time. Therefore, they are not enough, because the school is too big. Form one students up to form six students use the lab, and it is not enough. …not very often we use the lab, because most of the time we are running short of time. Maybe, you have a topic like nutrition. You must conduct an experiment, so we select some of the topics, which normally are common on the exams, and expose [*sic*] them to the students to do experiments.*

Rubi's case: Students in form I, form II, and form III do not perform any experiments in the laboratory. They only get a tour to show them what the laboratories look like, and that is all. The laboratories are reserved for form IV and form VI only, because they are close to taking the national examination and they must learn how to conduct experiments on certain topics. Therefore, teachers focus on their preparations by giving them the highest priority. By the time form I students get to form IV, they do not know how to carry out any experiments, and therefore they have to start conducting experiments from scratch while they are already in form IV. Rubi remarked,

Form I, form II, and form III never come to the laboratory. If they come, it is only to see what is a lab… this is a lab, that is enough. But, normally, for form IV [they] also don't come frequently; we just say it is essential they should know a few experiments so that they are able to answer the exam questions…. We are interested in making student[s] able to answer questions on the examinations. A lab is required for only form IV and form VI students. So, whenever form ones reach to form IV level, they do not know or remember anything.

Rosanna's case: The laboratories are available, but they are not adequate for all the students. In those laboratories, there is not enough equipment, and therefore, the equipment will be replaced only during the national examinations for students to use it during the examinations. Even during the national examination, students have to wait for other students to exit the laboratories, because there is not enough space to accommodate all the students at once. Rosanna professed,

> *The issue is the lab; it is there, but is not enough for all O-level and A-level students. This is due to inability of money; the school itself cannot have all the facilities every time. These (apparatuses) are available mainly during the national exams, but there are few when they try to practice. So, we cannot practice everything and every time and with every student. It is a bit expensive; they cannot afford to buy them…. They are not enough, and when they reach the time of the national examination, we use even the other labs and students enter into labs in sessions. Because of the lack of labs and lack of instruments, they have to wait for other students to finish their exams, then they enter.*

Simona's case: When the laboratories were built, they were designed to accommodate approximately up to 30 students; however, Simona's classes are double that number, and there is no space for all of the students. Grouping students in such an environment becomes challenging for teachers like Simona. She avowed,

> *By that time, the lab has been built to accommodate a maximum number of at least 30 students, if the students must have enough space. Now, taking into consideration the number has risen to 63, such a laboratory cannot accommodate…. Now, that means what*

are you supposed to do as a teacher? If you have got practical work that means you have to spare time, you will have to prepare to group your students at least into two groups with what time.

Alpha's case: Typically, the laboratories do not have apparatuses to use for experiments. However, when the national examination is approaching, the apparatuses are purchased and reserved for students to use for the experiment sections on the examination. Alpha explained,

Most of the chemicals, we buy them for the apparatus during the examination time or national examination.

Muller's case: Students in form II, form IV, and form VI are given priority when it comes to using the laboratories. Since the chemicals are quite expensive, they are reserved for students who are about to take the national examinations. Students in the other forms do not perform experiments in the laboratories. Muller indicated,

We normally conduct experiments in case of form two, for those who are going to face the national examination, such as form two and form four, because the chemicals are very expensive. So, we have limited chemicals. For example, if the students are in form one and form three, we are not attempting to do the experiments. They do not use practical.

The laboratories lack electricity and specimens, important tools are missing, and the equipment is not enough. As a result, a teacher like Muller tries to use locally available materials as substitutions. Muller stated,

…the lab is not well equipped; things that are very, very important, like the source of heat and electricity, are not there. Of course, we are using the heat that is locally, like the spirit burner, kerosene stove, but we do not have the Bunsen burner. The drainage system or the water system also it is not good. There is no electricity, and some important apparatuses, like a fume chamber, etc., we do not have. So, it is not well equipped. Actually, even the specimens, we are lacking many specimens. They are not there.

Peter's case: The apparatuses are not enough due to the large number of students; therefore, the teacher felt that if he put students in big groups, some of the students would not be able to grasp the lessons. Peter specified,

We have the shortage of teaching materials, especially apparatuses. You can find that you have a few of those apparatuses, which make you have one group of so many students. Now, if you put a group of so many students, it is not very easy for all students to get what you teach them.

Albert's case: There is not adequate laboratory equipment, so the teacher drew diagrams on the board as a way of demonstrating theories to students. The number of students and the equipment available in the laboratory facilities do not correspond well. A teacher like Albert found it easier to use a teacher-centered approach in such a learning environment.

The other issue that we have is about facilities that we use to teach. We do not have equipment in the lab, so instead of that, we have to use diagrams. I mean, yes, a diagram that can be either in free chart, or you can draw it with chalk on the board, that is…so, *diagrams and reality are two things that differ. …for the student population that we have, facilities and materials that we have, we just use the teacher centered [approach].*

Alpha's case: On a typical school day, the teacher did not carry out experiments due to a lack of chemicals and laboratory equipment. However, during national examination time, the labs are equipped with tools in order for students to conduct practical work for the examination. Alpha indicated,

> *…we have a lack of apparatuses in this school, we cannot use practical, because we do not have equipment and chemicals. Therefore, for the national examination, we have apparatuses. But, in school learning or normal learning, we do not have them. Due to the lack of the apparatuses, there are some of* [*sic*] *topics, which require us to use the lab, but we do not go to the lab.*

All participants indicated the inadequacy of the laboratories and their equipment, and I verified this information when I observed a biology teacher at Alonzo Secondary School on July 18th. A normal class was conducted in a laboratory, because there was a large number of students, and the lab was the only space in which all of the students could fit. Basically, this laboratory did not have any equipment -- no electrical connections, no tap water, nothing. There was absolutely no equipment of any kind on top of the counters. Therefore, the lab was just used as a class in order to accommodate the number of students.

Conflict between government policy and education practices

This theme describes the circumstances resulting from the government's educational policy that secondary school teachers' face in the classrooms. In addressing the issue of instructional delivery for secondary education in Tanzania, teachers are required to shift from teacher-centered to learner-centered teaching methods so that students have an opportunity to effectively engage in the knowledge construction process instead of teachers “spoon-feeding” students with abstract information which may not allow them to think and act for themselves. Although teachers have been emphasized to use the learner-centered approach, they still utilize the traditional didactic teaching methods in their classroom practices due to the difficult constraints in the teaching and learning undertakings in researched secondary schools. This theme is divided into one sub-theme: Less consideration of real classroom conditions.

Less consideration of real classroom conditions

Science teachers have difficulties in implementing the strategies that are specified in the educational policy. Therefore, the government’s educational policy on the instructional methods does not correspond to occurring teaching practices of science teachers in the classroom. The sub-theme is divided into three sub-sub-themes which are (a) Syllabus length (b) Over-emphasis on exam preparation and passing the National examination.

Syllabus length

The length of the science curriculum and the emphasis on examination performance are extremely challenging for the participating schools. The study revealed that teachers recognize the value of using interactive teaching and learning methods; however, they deem that such a method takes a very long time and will hinder them from completing the syllabus by the end of the school year. In case it happens that they fail to complete the syllabus on time, the administrative officials will question the teachers to find the reasons for their delay in completing the syllabus. For this reason, teachers skip the experiments. If they perform practical work with their classes, they keep these activities very short, and other class activities will also be abbreviated so that they can meet the requirement of completing the syllabus on time.

Muller's case: The syllabus is too lengthy, which makes it is difficult for teachers to cover all of the topics. The time that teachers are allotted to teach in the classroom does not match with the teaching load they have to complete in one period. There are many topics described in the syllabus, and teachers find it impractical to complete all of them within the timeframe given. As Muller explained,

> *The biology syllabus is a very long syllabus; it has many areas to cover. The areas to cover in the syllabus are very long, so it is very difficult somehow to cover the syllabus. The materials to be covered are very many compared to the time allotted in the classroom. …the time given in the classroom and the allocation of periods are very few compared to the areas that we are supposed to cover.*

Rubi's case: A teacher like Rubi is concerned about the failure to complete the syllabus. Therefore, she gave students work to do at home well in advance, and when students come to class, they know the answers already, since they would have tackled the questions a few days before. They present their work in the classroom, whereby allowing the teaching and learning to be as quick as possible in order to save the teacher some time. According to Rubi, because there are so many groups, not all of them have the opportunity to present. She will only select a few to demonstrate their work to others. If she allowed every group to present, it would consume a lot of time. Some short topics that she can teach in 4 periods can take up to 8 days if she uses group work more often and if every group has to present. Therefore, she avoided using group work because of the fear of falling behind and being unable to finish the syllabus. Rubi asserted,

I normally prepare questions, and then, give them maybe 2 days before class. I tell them that you have to go and find the answers to these questions. Then, one student from each group will present in the next period to come. I tried to do that sometimes, but also, it takes a lot of time, because the groups are many and will not finish all, giving answers to those questions that I assigned concerning the specific topic. The topic that I think I would have finished maybe in four periods, I will take periods of 8 days. I am also afraid I will not finish the syllabus. With seventy students, how many groups and how many questions do you have to prepare? Now, those are many groups, now in a single period, would they all present? And, since they are very much interested in topics, they talk much. Time is very important in class, because I must finish the syllabus.

Simona's case: The curriculum is very lengthy and the time allocated for each teaching period is not as sufficient for teachers. As Simona affirmed,

…time factor and the length of the syllabus. The syllabus is very long, time that has been allocated to the period, it is not so sufficient.

The results of this study determined that the syllabi are too lengthy, and teachers are not able to cover all the material within the assigned timeframe. Thus, having to meet the requirements of examinations, teachers are forced to teach didactically. In addition, the study shows that the Tanzanian secondary school science curriculum is packed with content, while the time given to the teacher is insufficient to teach all the required topics. As a result, the teaching and learning activities focus on completing the syllabi rather than on understanding the scientific concepts and processes.

Over-emphasis on the National exam

Vivian's case: Teachers have to complete the syllabus, and in a case they fail to finish, the following year, they must continue where they left off. The inability to complete the syllabus at an allocated time may result in students' failure in their examination because the questions on the examinations are designed based on the syllabus. This is the reason teachers are pressured to finish the syllabus. For teachers who do not finish the syllabus on time, they are at a risk of not completing the syllabus again for the following year because more topics are added on top of what they are required to teach in a year. As Vivian explained,

You have to finish, you have to finish because we make a scheme of work for a year, you have to finish, because if you don't finish it means in the next year you have to finish these topics first so that you can begin the next years topic, so it will delay you to finish the other syllabus and because we have annual exams and for form two for example we have national exams, the national exams assume that all teachers have completed the syllabus of form one and form two so if you don't finish it will be loss for the students

Albert's cases: A teacher like Albert tries his best to ensure that he completes the syllabus so that students can perform well. He affirms,

Yeah… we are trying to make sure that the students are able to do the exam and pass it.

Alpha's case: The examination questions are set based on the syllabus. As Alpha stated,

In examination, the questions should be asked according to the syllabus.

King's case: It is a requirement that by the time the form four students are about to sit for the National examination, the syllabus must have been covered. Therefore, the topics covered in the syllabus must be in line with the National examination topics so that students are able to tackle the questions. King asserted,

> *The final exam of form four students is based on the syllabus. So, the teacher must make sure that he aligns with the syllabus so that by the end of the four year program, then the syllabus is well covered.*

Muller's case: According to Muller, in the case that the teacher has not covered the syllabus as required, then students will have challenges in performing the examination. A teacher like Muller strives to complete the syllabus to meet the requirement, however, it is hard because there are many topics presented in the syllabus but it is not realistically easy to implement them all in a given time. Muller professed,

> *There is an effect to the students because if you don't finish the syllabus or cover some areas, if those areas come to the examination, some questions are constructed from the areas that were not covered, of course the students will have problems in doing the exam especially the final examination, though we are struggling to cover the syllabus, but somehow it is difficult, yes. There are many things described in the syllabus, but in reality, when you are coming to teach, it is very difficult to cover each area described in the syllabus.*

Simona's case: The teachers are cautious to meet the goal set by the government which, in this case, is the completion of the syllabus. Simona is aware that if the syllabus is not completed by the time students have their examinations, there is a chance that students will not perform well because they will not be able to tackle and answer some of the uncovered topics they did not learn. She does whatever she can to ensure that she completes the syllabus; she avoids the experiments to hasten her teaching, and when she thinks she has covered most of the topics and she might have time for experiments, she does so by demonstrating. As Simona declared,

> *…in form two, there is the national examination; in form three there is [the] Regional examination. In form four there is [the] National examination, therefore in each level of education, you make sure that you have completed the syllabus because the NECTA exams, even the regional exams, do not mind whether your school is behind or [whether] you do not have teachers, there are no teachers, whether students were not taught! [It] is up to you. Look for any means of eliminating these problems so that we meet what the government has targeted. That they [students] must complete the syllabus and they must do the exam according to the syllabus. People are now trying, if I do this experiment, I will not complete the syllabus, therefore it is better I rush to the syllabus; if there is time then I can come back and do some few*[*sic*] *experiments.*

Viola's response: According to Viola, the heads of school and department are more concerned with completing the syllabus and ensuring students pass the examinations. Teachers' performance is assessed by the outcomes of students in the National examination. Therefore, Viola could do whatever it takes to ensure that she covered the syllabus in a timely manner. As she avowed, *What the head of department or head of school needs is to cover the topics and the students to pass, and we Tanzanians, we choose to look for the National examination. So how can they measure my performance? They measure my performance by considering the National examination results. As a teacher, my students will sit for the national examination while two topics are not covered I feel pinched. I can use any mechanism to make sure that the topics are fully covered.*

Most of the participants expressed their fear of not completing the syllabus on time. The over-emphasis on examination preparation for students compelled teachers to adopt transmission methods such as lectures so as to cover overloaded content and to convince students to memorize their notes which were considered vital for passing their final examinations. Clearly, this is a dilemma which shows that students' skills are assessed based on their ability to recall memorized facts, theories, and formulas. This teaching practice does not correspond with the current curriculum's viewpoints in teaching and learning where the focus is put on active engagement of students in the learning processes.

The following section seeks to answer research questions 3 regarding the science teachers' understanding of inquiry-based approach.

RQ: How do science teachers come to understand and make sense of what an inquiry-based approach mean in teaching science?

Theme: Based on governmental constraints and professional development of teachers, teachers are not aware of the inquiry-based approach.

This theme answers the question about how science teachers come to understand and make sense of an inquiry-based approach in teaching science. The theme has one subtheme titled *No experience in using inquiry as a mode of delivery of instruction*. This subtheme will be discussed in more detail below.

Table 11. How Science Teachers Understand Inquiry-Based Approach

RQ and how it is answered	Themes	Sub-themes
How do science teachers come to understand and make sense of what an Inquiry-Based Approach means in teaching science?	Based on governmental constraints and professional development of teachers, teachers are not aware of the inquiry-based approach.	• No experience in using inquiry as a mode of delivery of instruction o Unawareness of inquiry o Project as inquiry

No experience in using inquiry as a mode of delivery of instruction

This subtheme discusses that participants did not implement the inquiry-based approach because they were not aware of it. The sub-theme is divided into three sub-subthemes which include the following: (a) Unawareness of inquiry and (b) Project as inquiry. Each of these sub-subthemes will be further explained below.

Unawareness of inquiry

All the participants declared that they were not aware of the inquiry-based approach. They do not know this kind of teaching method. Most of them, in fact, asked me what inquiry-based approach meant as they were curious about it. Participants' remarks about this teaching approach are presented below.

Alpha's case: The inquiry-based approach was new to Alpha. He was not aware of it. Alpha asked me if I could explain to him what this method is all about, and after explaining to him its meaning, he presumed that even if he knew about the inquiry, he was not going to be able to use it because of shortage of teaching materials. In his own words, Alpha stated,

I have not heard about the inquiry-based approach, not yet. We can't use this method of teaching because of lack of apparatus and because we cannot provide students with apparatus, or even text books to provide to students. Yeah, we don't have those materials which I have said which require this method of teaching.

Vivian's case: The word "inquiry" was familiar to Vivian as she thought it involved asking questions. However, she did not know that inquiry is a teaching method and for that reason, she has not used it before. Vivian professed,

> *I know inquiry is about asking questions but as a method I don't know about it. However, I ask questions in my teachings, I try to know what the learners know especially before I begin the topic because I need to get the prior knowledge of the learner so I cannot bore them with what they know, but as a teaching method no. I have not used it in my class.*

Muller's case: It was Muller's first time hearing the term "inquiry-based approach." Even though Miller was unaware of the inquiry-based approach, he thought that such a teaching method would require a fully equipped laboratory so that students would be able to perform a variety of activities. In addition, Muller pointed that students' enthusiasm to learn is not as high. The majority of students regard science subjects as more difficult than other subjects such as art or commerce; thus, they are disheartened. As Muller expounded,

> *No, I'm not familiar with inquiry-based approach. It is my new word today. The main problem in our school, it is the facilities, we don't have the facilities. Because when you introduce such a method, you have to guide the students by providing the facilities, so they can do observation, they can conduct an experiment, they can interpret data observed and do the conclusion. But if you don't have materials or the facilities to provide to students, it is very difficult to conduct such a learning process. Yes, and apart from materials, the readiness of our students nowadays is not good. Most of them are not ready to study especially science subjects thinking that they are more difficult than other subjects. So, they are discouraging themselves that science subjects have no future compared to other subjects like commerce, book keeping, etc. So even when you go to the classroom normally our students nowadays they are run…they run from the studying of these science subjects.*

Peter's case: According to Peter, he had heard about the inquiry-based approach but he has never used it before in his teaching. Once I defined the inquiry-based approach, Peter thought that considering both the time allocated and students' ability to perform inquiry activities, it will be difficult to use such a method. He alleged that the students will take a long time to complete the tasks. Thus, he believed that this teaching method could be designed for higher level students. In his own work, Peter claimed,

> *I heard about that method but in my teaching, I have never used that method. The problem I think it will be difficult to use that method because of the ability of students to do those activities in the allocated time, I think will not be enough. I think it will take a long time for students to finish the work. Maybe that method can be aimed for a higher level of education.*

Simona's case: Just like other teachers, Simona did not know what the inquiry-based approach was. She believed that it is written in books; therefore, she planned to research so that she can learn more about it. As she stated,

> *No, I don't know inquiry-based approach, what is that? No, it is probably in the books, probably I have to reference it.*

Sydney's case: This was Sydney's first time hearing about the inquiry-based approach. Once I explained this teaching method, Sydney confused it with the student-centered approach. She acknowledged that most of the teachers do not implement it in the classrooms.

> *No, I have not heard about it, not much. In fact, I was confusing it with the student-centered [approach] but this sounds to be new. It is not new as such but I am sure most of the teachers are not using it.*

Viola's case: The term inquiry-based approach was new to Viola. It was her first time hearing such a teaching method and she declared that she did not know it. In her own voice, Viola avowed,

> *No, I have never heard about the inquiry-based approach before. I do not know that teaching method.*

As participants described that they were not aware of the inquiry-based approach, in all the classrooms and the laboratories that I observed, the teachers did not use the inquiry-based approach to teach their science students in the classroom. For the most part, the teacher was active, and the students were passive. Although a few teachers started their new lessons by asking their students questions to learn about the prior experiences of the students, the inquiry-based approach is more than just asking questions. The section below describes the lessons I observed in the physics classroom at Alonzo Secondary School.

On the afternoon of the first day of August, I had an opportunity to observe a chemistry classroom at Alonzo Secondary School. The first thing I noticed was the number of students in the classroom; the number of students was more than the room could accommodate. Some of the students did not have chairs, so they stood up. Simply put, there was no space for the teacher to move around and give students individual feedback. In the same way as the Physics class, the teacher put a larger emphasis on facts and chemical symbols. In this classroom, the teacher asked students questions regarding elements, and she used three-quarters of the class period to teach elements. The rest of the time she wrote notes on the blackboard. The following section provides more details of how the class was conducted and observed.

The Teacher and Researcher go into the classroom.

Students: Good afternoon, madams

Teacher and Researcher: Good afternoon, students. How are you?

Students: We are fine, thank you, madams.

Teacher: Please get seated.

The researcher walked to the back. One student offered her a chair, and the student stood up.

The teacher wrote the topic on the board, and it read "Element, Compounds, and Mixtures."

Teacher: Today, we are going to start a new topic. Who can tell me the meaning of element?

Student: It is a pure substance that cannot be broken down into any other substances chemically.

Teacher: Is that correct, students?

Students: It is correct, madam.

Teacher: There are different elements. Which ones do you know?

Students: Oxygen, Hydrogen, Sodium, Copper, Potassium, Helium, Silver….

Teacher: Where do we find oxygen?

Students: In the air.

Teacher: And, where is air formed?

Students: In the atmosphere.

Teacher: Any elements that are present and you have seen?

Students: Sulphur, powder, yellow in color….

The teacher brought some elements into the class. They were in bottles.

Teacher: This is Magnesium Phosphorus, and it is in oil. Why do you think it is stored in oil? Why is Phosphorus in oil?

Student: It is to prevent from contamination.

Teacher: Who is able to mention at least 10 elements without looking?

Student: (1) Hydrogen, (2) Helium (3) Lithium (4) Beryllium (5) Boron (6) Carbon (7) Nitrogen (8) Oxygen (9) Fluorine (10) Neon….

Teacher: Scientists use symbols to represent elements called "Element Chemical Symbol." Every element has its own symbol.

First Mechanism: Some elements take the first letter of the element, which ones are those?

Students: Hydrogen (H), Carbon (C), Sulphur (S), Nitrogen (N), Phosphorus (P), Fluorine (F) and Oxygen (O).

Second Mechanism: Take the first letter and the second letter to avoid ambiguity.

Teacher: Beryllium Be, Boron B, to make them unique. Or, Carbon C and Calcium Ca – the first letter must be capitalized, and the second one must be small. Now, give examples of 2 letters.

Students: Silicon Si, Argon Ar, Aluminum Al….

Teacher: Stop making noise please!

Teacher: Magnesium Mg and Manganese Ma – they both start with Ma, and that is why Magnesium uses the first and third letter.

Teacher: Take your Chemistry exercise book; write the first 20 elements together with their chemical symbols, and bring it to class the next period we meet.

The Teacher started writing notes on the board, 14 minutes later, the class was over.

The teacher asked students to read about this topic well in advance before she actually introduced the topic in the classroom. By the time the teacher came to class to introduce the topic, students had already been provided with some of the notes and were ready to answer any questions from the teacher. This observation revealed that teachers focused their instructional efforts to the activities that would obstruct students from understanding the science concepts which contradicts what inquiry-based instruction means. Therefore, teachers did not focus on the development of competence based on what the inquiry-based approach would do.

Project as inquiry

Most of the participants regarded inquiry-based approach as a "project" which students have to conduct as part of their assignment.

Albert's case: After defining the inquiry-based approach to Albert, he indicated that they regard it as a "project." Students at his school perform activities that are related to the inquiry-based approach. Albert asserted,

> *According to what you have said, here we have the so-called project, yeah, a project, that student themselves they can sit down and find out problems, find the solution, and also, they may present.*

Simona's case: The moment Simona heard the definition of inquiry-based approach, she indicated that at her school, it is viewed as "project." For this project, students visit places outside of their school and carry out various activities in order to complete their assigned project. Simona described in detailed about how students go about performing the project. She expounded, *Yeah, that method for us we call it project. I had a group of students of that kind, they did a certain kind of investigation. For example, the first one was that they passed through certain market areas and they saw that a lot of lemons and limes were thrown away after being used and becoming rotten. But from students' knowledge what they thought was that the juice extracted from lemons and limes can be used as a disinfectant therefore they came up and say that why don't we make a project on these limes and lemons which are dead as waste in the market. Then, they started. They extracted the lemons, they got the juice, and they used it to see, what can we do with this? They cleaned the sinks, and the sink became white. They cleaned the floor, the floor in fact showed some sort of patches, but in the ceramic areas, they used that juice and it was purely cleaned and it shined. Therefore, they came up with a project of making disinfectant from lemons and limes which have been wasted. Therefore, they concluded that instead of these people throwing them away then can extract disinfectant for cleaning ceramic areas.*

According to Simona, students would conduct such a project for as long as 6 weeks. As she stated,

I had supervised three projects and each one took between 3 to 6 months.

Theodora's case: According to Theodora, inquiry-based approach is also regarded as a "project." The project is an outside activity whereby students leave their schools to investigate the life circle of insects, and their common characteristics. They also collect data such as the number of legs for different insects, and their movements. When it is time to teach a topic such as arthropods, students would have the data they would have collected in the form of a report.

Hence, the teacher and students discuss and summarize. Theodora indicated that students' projects are graded and serve as continuous assessment. Such a project is intended for advanced level students rather than Ordinary level students. Theodora explained in full about the procedures on how students carry out their assigned project. She maintained,

> *Students visit perhaps various areas surrounding our school, a teacher assigns them in groups to investigate the life circle of insects. One group will investigate habitat, feeding methods, and perhaps how do they live, some will deal with cockroaches, others deal with grasshoppers, others deal with let's say butterflies. Then when you are teaching about arthropods for example you get a lot of information from the students themselves, they bring back their reports, you discuss the report thereafter you summarize. Then you will get habitats of arthropods, individual organisms, how they are fed and their characteristics. The also look at other things such as legs: Others have three pairs of legs and others have two pairs of legs etc.; how do they move, others just use wings, others just use legs, how many legs, etc. Students' work is graded as a group and it can be one of their tests or continuous assessment mark. But, such a project is very much applicable for Advance level students rather than Ordinary 'level students.*

Rosanna's case: As other teachers, Rosanna considered the inquiry-based approach as a "field trip." According to Rosanna, the teacher takes her/his students to an area where they will be able to conduct an investigation. In her case, students would examine soil and determine the types of soil and their components. At the end of the investigation, students would write a report. Rosanna provided a description of the project, and she explained, *This inquiry can mean like a field trip. You take the students out of the school to the field place and the student can read, can study maybe chemistry by examining different types of soil and investigate soil components. Then, they come to write a report.*

Viola's case: Upon hearing the definition of inquiry-based approach, Viola recognized it as "project" that students at her school carry out. Viola taught her students how to make soap both in the classroom and in the laboratory using chemicals found in the laboratory such as sodium hydroxide. However, students discovered another way of making soap naturally using sodium hydroxide found in ashes. Viola encouraged students to find ash and make soap sodium hydroxide with cooking oil to confirm whether it works or not. Such a project would take about two months. Viola provided a description of the project, and she explained,

> *This method looks similar to what we call "project" here in our school. Our students' investigation is done by the students only when they need to do their project. Up to this point, I have one group of students trying to make soap. In class, we used to make soap, and we learned how to make soap. In the laboratory, we used to make soap by using sodium hydroxide which is in the laboratory. We needed to use cooking oil and we mixed [it] with calcium carbonate and we make soap, but these students tried to find another natural source which provides sodium hydroxide apart from that which is used in the laboratory. So, they tried to find out which substance/which natural substance contains sodium hydroxide, they found out that ash contains sodium hydroxide so they come to me and said "Madam we found out that sodium hydroxide can also be obtained from ash, so we need to prepare soap by using the cooking oil together with sodium*

hydroxide then we can find out what is going on." I encouraged them that they should find the ash, make it then the next week come in the laboratory we try to make soap and we can find out if it really works. From that point, after we have performed that exercise, we can see if it really works or not. That is among the projects. It can start from May up to July.

King's case: When King heard the term "inquiry-based approach" he indicated that they call it a "project" at his school. Students are required to complete the project before they sit for their National examination. Teachers give students some guidelines and students go outside of their school zone to do research work. As King affirmed,

A project is one of the methods or techniques that students need to do and it's also a requirement by the national examination council of Tanzania. It's a requirement that students should do a project whereby they are given some guidelines by a teacher and they go outside to find some data and analyze and write a report on what they found outside while the teacher remains to be the supervisor, we do that here.

King's case: King compared inquiry with the project students do at their school and believed that they are almost 100% similar. He thought that way because in the project, students make observations, discover, and pose questions to obtain information. Then, at the end, students report their discovery to their teacher and show him evidence to support their analysis.

Yeah, we might be using on the other way, mind you in the beginning, I shared with you the so called project, that project it is almost a 100% related to the inquiry because students are going to find, get some findings, make observations, and ask some questions *to get some data. And then later, they come back to me, their supervisor, trying to show what they have discovered with this evidence*.

Most of the participants indicated that they deemed the inquiry-based approach to mean what they called “projects” in their schools. Most of these projects were conducted out of the classrooms and did not follow any of the levels of inquiry. Students might have gone out of their schools to conduct research as the requirement for their projects or even perform hands-on activities, however, this did not mean students were applying inquiry-based approach because their activities did not involve research questions or even data analysis; thus, their project efforts did not qualify as inquiry activities.

Moreover, none of the participants mentioned that the activities involved in the project started with a scientific question, and that students analyzed the data they had collected. This confirms that the project is different from the inquiry-based approach because inquiry-oriented activities must begin with a scientific question and must engage students in analyzing relevant data. Therefore, involving students in a hands-on- investigation does not signify an inquiry lesson. In such research activities, students collect data but do not analyze it to answer their questions.

The section below introduces other findings that emerged as a result of this study. Other findings were participants’ remarks regarding the state of their working conditions and other factors that influenced their classroom teaching. The theme is divided into two sub-themes which include (a) Poor service conditions and low motivation and (b) Classroom management difficulties. Both of these sub-themes will be discussed in detail below.

Table 12. Other Findings

Theme	Sub-themes
Other findings	• Poor service conditions and low work morale o Lack of motivation o Low salaries o Shortage of teachers and teacher incompetency o Overworking • Classroom management difficulties o Large classroom • An informal meeting forum o Peer-support

Poor service conditions and low work morale

This is the first sub-theme for other findings. The findings of this study show that some of the participants are dissatisfied and unmotivated due to various reasons. Teacher morale is low due to the condition of service and other factors such as remuneration packages, their inability to handle large numbers of students, etc. This sub-theme has four sub-subthemes which are (a) Lack of motivation, (b) Low salaries, (c) Shortage of teachers and teachers' incompetency, and (d) Overworking. All these will be discussed in detail in the following section.

Lack of motivation

This is the first sub-subtheme which derived from the sub-theme "poor service conditions and low morale." It discusses low levels of motivation science teachers face. The participant below expressed how he felt in terms of motivation.

Albert's case: A teacher like Albert highlighted that he has been in a teach profession for a long time, but his experience has not been positive. He works hard, however, he lacks motivation. In his own words, he proclaimed,

> *From the experience that I've got from this number of years that I've been teaching we have no motivation, we do a lot of work but no motivation. That is also the problem that we have.*

The participants indicated that there was no motivation for teaching science subjects. The lack of motivation stemmed from many factors which have a negative influence on teachers' performance such as working conditions, low salaries, handling large class sizes, etc. Being poorly motivated, teachers find it difficult to fully engage in the teaching process and this may lead to undesirable science educational outcomes. Therefore, the Tanzanian government should strive to improve teacher well-being and motivation so as to ensure quality instruction in the science classrooms.

Low salaries

This is the second sub-subtheme which will discuss the remuneration of teachers. The teachers strive to put efforts in teaching science subjects but their remunerations are not satisfactory. Participants mentioned that a good salary would help them meet their basic needs and therefore they would be able to concentrate on teaching activities. However, since they receive low pay, it is hard for them to give students their full attention because they also worry about where they can find money to meet their needs.

Simona's case: Simona compared the work she performed, the time she spent preparing the laboratory activities, and the salary she earned. She realized that she was not being compensated adequately. The salary she was earning was not enough to meet her basic requirement, therefore, Simona uses some of her time to conduct tutoring sessions to earn extra income in order to make a living. According to her, she earned much money working a side job. She declared,

> *It is very difficult for me to prepare experiments, you see... I have to impose a lot of time again for students…in most cases I consider* [*sic*] *myself "Should I prepare this, should I do this?" No! Because I do not have money, I have to go somewhere and look, conduct tuition [tutoring] there, I get a lot of money therefore I will do this theoretically tomorrow. That is what I do.*

The days Simona does not engage in any tutoring activities and when in good spirits, she can decide to teach students how to conduct experiments. In this case, she would ask her students to stay after school so that she can teach them successfully. She would have earned enough money from tutoring services, and that would put her in a good mood to teach students. Simona professed,

> ***Simona's case:*** *Now, time is a factor for the preparation. I am telling you, time is a factor for the preparation, but when I am in a good mood, I can do it [experiments]. I can even volunteer to do it during a special time, when I know, ah, this time I am free, and I do not have anything to engage me. Then, I can decide to go there [to the lab] and arrange my experiments, and then, I call my students, come in, do experiments, and I will*

supervise. That time, I have no tuition; I have nothing. The source of income is good, then I better go to my students now and teach them effectively. I am telling you the real facts; really, I am telling you the real facts.

Muller's case: Because of the low salary Muller received, he was not able to buy any tools that could help him in his teaching. As he indicated,

According to our salary, I think you know, I'm not sure if you know that you cannot use your money to buy local materials for conducting experiments for the students. Somehow, it is very difficult.

Muller's case: Like a majority of participants, Muller said that his pay was minimal and insufficient to meet his basic needs. This situation affected Muller's concentration on his teaching, because he could not just focus on performing his work effectively, as required. Because his salary was low, he worried about how he would meet his basic needs, how he would pay for his child's tuition, and provide food for his family. He thought about all these issues while he was in class teaching. His mind was preoccupied, and his ability to teach was affected. Conversely, if the salary was sufficient, he would not have been concerned about money, and he would have contributed all his efforts to teaching. In his own words, Muller affirmed,

You have no money in your pocket, and you think, I have left my family with no food there. Can I concentrate? Can you stand in the classroom and teach, teach effectively? At the same time, you are thinking about your family; at the same time, you are thinking that this money I have in my pocket, it will not get me to the end of this month. I have fear about how can I go back home today. Many things of course in these environments are *not good for the teachers to teach. You can't concentrate well in the classroom. But, if I know that my family has the basic needs, like food, shelter, and if my child is sick, I can treat him, and I'm able to pay the school fees, etc., then even my performance will be different.*

When Muller was in the classroom teaching, he considered if he would have enough bus fare. He was also thinking about how he will get money to buy items that would help his and his family's health, such as food, medication and so on. All these issues affected the way he taught his classes; however, if these challenges had not existed, then that would have ensured that he could teach effectively, and as a result, students' learning experiences would also be positive. In his own words, Muller affirmed,

Our salary is not enough. So, when you are teaching and, at the same time, you are thinking about bus fare or about buying something that will make you to be in good health or whatever the case, I think you will not concentrate in the classroom. So, if there are no issues that are disturbing his mind or her mind, then the students are able to learn and the learning process will be good.

Albert's case: According to Albert, science teachers had a great deal of work to do and used a lot of time in their work, but they earned less than other teachers who did not teach science subjects. If compared the salaries of teachers teaching other subjects and teachers teaching science, and the salary of science teachers was lower and this was one of the challenges that science teachers, like Albert, faced. He stated, *You cannot compare science teachers to the other teachers. If you compare the work that other teachers do and their salaries are different compared to science teachers who use much time to do the sciences but get little. That is the challenge which I have.*

Rubi's case: According to Rubi, science teaching demanded a lot of work, but the pay was low. In other words, the work and the pay were not comparable. For this reason, there were only a few Physics teachers at Rubi's school, because some teachers had left their jobs. This meant that low salaries affected the teaching profession, because teachers would leave, and now, there was a shortage of science teachers. As Rubi declared,

Physics teachers are very few now, because the work is hard, and the payment is small. So, can you imagine teaching five classes alone? How can I perform and be able to finish the syllabus…and to do everything with that number of students? It is very, very difficult.

Even when participants used their extra time to teach, they still earned the same salary. Since the time was limited, participants like Rubi would be willing to use her extra time to teach students. However, if she used her extra time to teach, she would not get paid for it. There wasn't any supplemental pay. For that reason, Rubi stopped spending extra time on her students, and her concern was that students would not enjoy the subject as they should, because they would not be given enough attention or time to understand the subject. If she was paid for the extra time she used to teach students, then she would be motivated to do whatever it took to spend numerous hours with her students. Rubi averred,

The time is not enough, so I have to use my extra time. So, if we are paid the same amount of money, where would I get that time to teach these students so that they can *enjoy the subject? But, if it were enough money, then it would give me an interest to be with students for a lot of hours.*

Participants have been negatively affected with insufficient remunerations. The above responses from participants revealed that teachers' salaries were not sufficient to meet their basic needs. Some teachers faced difficulties helping their families financially and that forced some of them to engage in tutoring activities to generate extra money. Their payments discouraged them from being dedicated and committing to their teaching work. Instead, they concentrated more on tutoring than their classroom teachings. Therefore, this study discovered that teachers' low remunerations discouraged teachers from teaching effectively, thereby negatively influencing their teaching practices in the classrooms.

Shortage of teachers and teachers' incompetency

According to Simona, government-funded schools had insufficient teachers, which means that one teacher is expected to do more than she or he can handle. She compared the private schools to government schools. She indicated that private schools have sufficient teachers, and their salaries are better than those of government school teachers. Due to a shortage of science teachers, she revealed that teachers fall behind in completing the syllabus and that teachers do not have adequate time to do revisions. In her own words, Simona declared that she was unmotivated, and she did not really care if students failed. After all, they were government funded students. These situations forced her to be bitter and teach hastily and unwillingly. As she asserted, *Government schools, and particularly for science teachers, they have no science teachers. In private schools, there are many science teachers, and they are well paid, and they are well motivated. Therefore, they are there, and they impose extra time with students. Therefore, they teach them, and they can complete the syllabus in time and make enough revisions for what has not been covered well. For our case, we might find out that the exams are approaching; you have got two, three topics not yet covered, and then, you start rushing, because you know the exam will cover as far as here. Now, do you think the performance will be the same? This is what is facing us now. We do not have enough teachers, and therefore, you are trying to rush. That is the challenge we are facing; there is no motivation. Why should I [care]? Let them fail; they are government students. That is what is being done.*

Alpha's case: According to Alpha, teachers were not knowledgeable about how to use laboratory equipment, and he felt that limited pedagogical competency was one of the reasons that prevented them from completing the syllabus. Alpha stated,

…we are not competent in using the apparatus. Most of the teachers have [a] lack of competency using those apparatuses, and most of the teachers fail to do so. Now, this causes the failure to meet the requirement of finishing the curriculum.

The research findings showed that the shortage of science teachers at the researched schools led to large classes and a heavy workload for teachers and that these teachers have limited pedagogical skills in terms of conducting experiments. A single teacher should have a manageable number of students and periods in a week so as to give him/her adequate time to plan lessons, prepare material, and to deliver the lesson effectively. However, the data collected from the teachers revealed that there were teachers who taught more than 20 periods per week because a few teachers who were available had to be shared by a large number of students. This places a heavy workload on other subject teachers. In order for teachers to teach their subjects effectively, an adequate number of qualified teachers should be available in their schools.

Therefore, considering this challenge, irrespective of a great emphasis placed on science subjects, teaching and learning of science in this kind of condition may not yield favorable results. Furthermore, the information obtained revealed that some teachers did not know how to use laboratory equipment well. Their experiences indicated ineffectiveness in conducting experiments, which could result in carrying out inaccurate experiments in the classroom or laboratory. In order for teachers to teach effectively, a sufficient number of qualified teachers should be available in the school.

Overworking

The study findings discovered that schools did not have laboratory technicians to help teachers. Thus, this made science teaching difficult and tedious, because teachers served as the instructors as well as the laboratory technicians. Teachers expressed this lack of experience with the laboratories as a challenge, because they taught in the laboratories without any aid, while the large number of students in their classes was difficult to manage with only one teacher for the whole class period.

Albert's case: The schools did not employ lab technicians. Therefore, the teachers served a dual role as teacher and lab technician, doing the work of a technician and also fulfilling their teaching roles. As Albert stated,

> *We do not have lab technicians. We don't have. The teacher himself or herself conducts the laboratory technician's work and also teaching the class. That is also the problem.*

Simona's case: These two roles fulfilled by a single teacher made the work difficult for science teachers. There was no lab technician to help the teacher, so Simona had to assume both functions. As she indicated,

> *I am a teacher and a technician. I go and prepare my solutions and go on with my experiment without thinking that who is going to join me here, who is going to assist me here. I just prepare each and everything.*

Theodora's case: According to Theodora, the teacher was everything, meaning that she/he acted as a teacher and a laboratory assistant. It was disadvantageous if the teacher was inexperienced and did not know how to carry out the lab work. As Theodora affirmed,

> *Taking into consideration that we do not have lab technicians in our government schools at the moment, you are a teacher; you are a lab technician; you are everything. Now, how are you going to prepare this without experience?*

Most of the participants indicated that their workload was heavy given the large number of students they had to teach and the absence of a laboratory technician. Not long ago, the government furnished laboratory technicians but at the time of the interviews, the government had stopped providing lab technicians. These teachers are faced with a difficulty of serving as teachers and laboratory technicians—this is a tough task for them. This situation makes teachers feel dismayed because they are aware that other subject teachers tend to have relatively low teaching loads, however, the science teachers who usually spend most of the school day and after school activities helping students are burdened. Thus, teachers may not perform their jobs effectively as a result of being dissatisfied with their work.

Classroom management difficulties

This is the second sub-theme which was derived from the other findings. This subtheme includes the challenges that science teachers encountered in regards to classroom management. The sub-theme has one sub-subtheme, *large number of students*, and it will be explained in full below.

Large number of students

In the researched secondary schools, a class can have as many as 80 students. This excess hindered teachers' movement and decreased the possibility of conducting experiments or even group work. The teachers had a difficult time coping with the large number of students. According to the participants, they taught a large number of students in the classroom, which prevented effective discussion and ways of giving students feedback both as individuals and in groups. Due to the large number of students, the teachers found it difficult to teach effectively and carry out activities in meaningful ways. Because of the shortage of teachers in science subjects, at some schools, classes were combined, and one teacher was expected to teach all of the students.

Albert's case: Due to a scarcity of teachers, two classes were combined together to form one to ensure that each student was getting the necessary hours over a term. Then, one teacher taught the combined class, and according to Albert, the size of the physical rooms were not big enough to handle the overflow. Albert affirmed,

> *So, you combine those classes so that every student is learning according to the number of days that are required to be taught. Therefore, you find that you have a big class. The big class may be because of rooms that we have, may be because of the few teachers that we have.*

Peter's case: Managing group work in class was a challenge for teachers like Peter because of the number of students in the class. Group work required having enough time, and because they had so many students, the teaching pace was very slow. As he explained,

> *Now, the challenge that I face is that there is large number of students. In previous years, the classes were supposed to carry about 30 students, but now, there can be more than 40 in class, and putting them in groups will take a very long time. Therefore, we have to teach and learn a very small part of the topic for the whole period. Therefore, that is the challenge, and it makes me move very slowly with the syllabus.*

Rubi's case: There were so many students in combined classrooms that they occupied the whole class, reaching the blackboard area. In this case, Rubi felt the only way to illustrate the practical work was on the blackboard instead of allowing students to conduct their own experiments. As Rubi professed, *This is a small lab, and there are 80 of them for a single class. This lab is for form four and form six. At what time would you bring other students to the lab? …and in the class, they sit near the blackboard. There are a lot of them, so how would you let each one of them to do the practical in the class? ...in the class, you bring those measuring cylinders and do everything on that blackboard there, in the front there.*

Based on the experiences of the participants, the large classrooms were problematic not only for the teachers but also for the students. As most of the participants specified that they teach a large number of students in their schools, I confirmed this information when I observed their classrooms. The students filled the classrooms, and truly, in some of the classes, it was difficult for the teacher to actually pass through the students to follow up and assist students individually, even in a large classroom. As a result, students became passive. The physical classroom could accommodate about 25 to 30 students. However, for the researched schools, those numbers doubled, and therefore, it was a challenge for one teacher to handle such a number, some sitting and others standing, because there were not enough chairs for all of them. While experiencing this challenge, teachers are still expected to teach in a successful manner, to meet the students' needs and those of the curriculum.

An informal meeting forum

This is the third sub-theme derived from *other findings.* It includes the organized meetings, which gave science teachers opportunities to come together, engage in and share their challenges as well as their teaching practices. These meetings served as a form of professional development whereby teachers learned from each other and worked collaboratively with knowledgeable teachers to construct knowledge among themselves. Some of these meetings were departmental, and others were self-organized efforts.

Vivian's case: Teachers helped each other and strived to solve their problems and teaching issues they encountered in their classrooms in partnership with their colleagues. According to Vivian, supporting each other was a norm at their school. If a teacher was struggling with a topic in a certain area and she/he was not sure of how to teach the topic, she/he could receive assistance from more knowledgeable teachers. At times, such a teacher could be invited to another teacher's class to observe how the topic was taught. Vivian averred,

> *Most of the teachers are willing to help. They can help, and they can teach you, or even, sometimes, we invite one another in the class so that one can teach, and you can observe how it is done. Yes, they are willing to do that. We discuss different topics, and if I find something new to me or something difficult or I don't understand well, then I go to my other teachers. I ask them. We discuss, and we reach a common agreement. Asking each other questions is very common here in our school. We ask each other. We sit as a department, sometimes; we discuss challenges, then we try to find solutions together.*

Muller's case: Teachers worked together on different aspects of their profession in this learning community; they shared knowledge and challenges and helped each other in solving problems. However, some of the problems were difficult to solve, because they involved money. Other than that, Muller indicated that the meetings were helpful, because in a case where a teacher did not understand an issue related to teaching, a fellow teacher could offer her/his assistance. In his own words, Muller expounded, *We can discuss the problems of the departments and how to find the solution to those problems, and we can share the ideas. However, other problems are unsolvable, because they require money. In the gathering, for example, if we encourage or insist on teaching by using experiments, at the end of the day, experiments normally require chemicals, and when you go to the laboratory, there are no chemicals. So, even such activities that we have planned to do normally do not work. Somehow, it is helpful, because you share the knowledge from your fellows. If you don't understand something, and maybe, your fellow understands it, it is easy to acquire the knowledge from your fellows. It is very, very, very good. Yes, it can improve even the teaching process in the school.*

Peter's case: Teachers learned by sharing their challenges and examining teaching practices with their peers in the meetings. For instance, when teachers experienced difficulties with a particular topic, they received an opportunity to observe a proficient teacher teaching that same topic. Peter believed that after observing a peer numerous times, eventually, the teacher would be able to master the topic well. As he proclaimed,

Sometimes, you can find that one teacher is very good at a certain topic. So, we can welcome your fellow teacher, who is good at that topic, and then, you can sit at the back of the class, and then, you observe how your friend is teaching. So, we tend to use that method of helping each other on those topics which are very difficult. Yea, so, when you are looking at your friend teaching now or several times, then you find that, then, you can catch up with that topic yourself.

Teachers discussed problems regarding the topics they were required to teach and suggested alternatives. According to Peter, when a teacher found a certain topic difficult to teach, other teachers were willing to exchange information and teach each other before attending to the classroom. As Peter remarked,

> *If a teacher, maybe, wants to go and teach a certain topic and there is an area that is difficult for him, then, teachers can come together in our office and try to attempt that problem before the teacher goes to class. So, we just exchange, or we can teach ourselves before we go to the class.*

Viola's case: In her department, they had a tradition of helping each other, especially when they faced challenges related to their teaching practices. Usually, when a teacher did not know how to teach a particular topic, she or he could seek assistance from other expert teachers in such an area. Viola affirmed,

> *If you feel you have a problem, personal problem on teaching your subject, you need to find a teacher who is able, and then, he/she will instruct you on that topic, because even our experiences are different. So, if I fail or I have a problem on teaching this lesson, on my own time, I find a teacher, and then, I ask, "I need to teach this lesson, but it is difficult…" So, he teaches me, and then, I go to teach students. That is normal.*

Viola's case: In the meetings, teachers had a chance to discuss techniques that would help them finish the syllabus in a timely manner and also share ideas about handling stubborn students. This learning community was safe in that teachers were not frightened to share their challenges or problems with each other. Instead, they had confidence sharing information and learning collaboratively together. Through these meetings, the level of interaction among teachers increased, and teachers were able to solve and eradicate their challenges. As Viola declared,

> *The meeting on how we can improve our teaching is just to discuss how we can manage to complete our syllabus earlier. And, if you have a stubborn student, we discuss how to deal with it, and if you have a problem on teaching, we talk about what you can do. This kind of meeting increases the interaction among us. By having those meetings, I feel free to express my challenges and try to learn from others. So, I think if we were not having those meetings, it would not be possible for you to be free to say, "Oh, I have this problem; I have this issue" and "help me to solve" or to eliminate those challenges. We have such meetings, and we, as chemistry teachers, we have cooperation; yeah, we have cooperation.*

Rubi's case: According to Rubi, teachers gathered together for the common goal of helping and supporting one another. Teachers had the freedom to ask each other questions regarding the experiments and had discussions on difficult topics. Rubi believed that sharing different perspectives can be a way of learning new ideas from others. She declared,

> *We have a group of teachers wanting to teach ourselves good practices on how are we are going to teach our students there. To share, should I say share, we have it, and I can call it a club. When we meet, we ask each other which experiments do you think are hard, and people will mention those experiments, and then, we can discuss. This is helpful,*

because we all have different views, and you can learn a specific topic which, maybe, you were lagging behind.

Simona's case: At Simona's school, they had departmental meetings where teachers brought in their opinions regarding their teaching practices. These meeting discussions involved students from all levels—the Ordinary level to Advance level students. In the meetings, teachers basically shared their opinions, encouraging each other that they should conduct experiments regularly, as Simona professed,

> *Yeah, we do discuss when we have got departmental meetings in the chemistry department. Everyone gives their views about teaching, not only for these O-level students but even for A-level students. You find that we encourage each other that teachers should use practical work. You can hear a teacher say that, "Please do practical work to enable students to understand."*

Sydney's case: At Sydney's school, helping each other was a norm. Teachers had departmental meetings where they spoke about the problems they encountered and strived to fix them together. In a case where a teacher had difficulties with a specific topic, she/he was welcomed into one of the other teachers' class to observe how the topic was taught. According to Sydney, this type of learning community was helpful, as it developed openness among the teachers, and teachers felt secure, because the assistance was offered freely by their peers.

> *We discuss various topics in our department. In case there is a difficult area for someone, or if she/he faces problems with a particular topic, someone can teach her/him, and the teacher will sit back in someone else's classroom and observe the way the other teacher*

is teaching, so we help each other. This is helpful, because we are open for each other. If you don't know something, don't just hide, because we are supposed to teach our students as required. We are supposed to give them the correct dose, so if you don't understand a certain topic well, we discuss about it in the department, and later, you can be invited in a class and see the way someone else is teaching that subject.

Albert's case: A few teachers such as Albert mentioned that each department worked individually; there was no collaboration work among them. As he explained,

The physics department is alone, the chemistry department is alone and biology is also alone. We do not collaborate within departments. Each department does its work separately; own their own. So we do not have that share, which is very important.

Albert indicated that there was a lack of communication among departments. He expounded,

We have those meeting, but like I have said, physics as a unit, they just stay alone. They have no communication among science departments.

Theodora's case: Teachers help each other in understanding various science topics. A teacher can simply ask their peers to teach her/him a topic that she/he is unsure about. According to Theodora, teachers assist one another and share some teaching materials. As she maintained,

You can request a person from the department to teach you a topic, just to help you understand it. For example, other teachers are not very willing to teach genetics, but I do attend their classes and teach genetics. I help them in the office before going to class, or they can even ask for some of the materials, i.e., how can I prepare this lesson? We help each other in the department.

The findings revealed that the departmental meetings and self-organized collective activities designed for and by science teachers served as opportunities for professional growth through peer-to-peer collaborative learning efforts. Teachers had a great level of trust and were willing to be challenged by their fellow teachers and according to them this the organized events led to the development of professional learning. Teachers in this study appreciated and valued the dialogue they established with their peers through which they were able to reflect and constructions knowledge. On the other hand, there were a very few teachers who mentioned that they did not have support from other science department. Each science department worked independently and was not normal for them to interact with other departments.

Chapter Summary

In this chapter, five major themes were presented from data gathered from semi-structured interviews with thirteen purposefully selected science teachers in addition to observations, document review and field notes. Five themes emerged within the findings and several closely related subthemes or categories were revealed because they were connected to the research questions. The following are the five major themes (1) Science teachers experience a range of access to government sponsored programs and generally have negative perceptions associated with the quality and availability/access of programs (2) Science teachers were self-directed in individually seeking PD through both higher and continuing education (3) Teachers use teacher-focused, traditional methods to teach science (4) Governmental resources, insufficient professional development, and curriculum demands inhibit teachers from using modern teaching approaches (5) Based on governmental constraints and professional development of teachers, teachers are not aware of the inquiry-based approach.

In the first theme, it was discovered that there were government sponsored programs in which not every teacher had access to them; therefore, this translates to professional development not offered and distributed equally. The second theme uncovered that there were self-directed learning activities that teachers undertook as part of their professional development and these activities were not supported by the government thus, teachers had to pay out of their pocket to attend. The third theme discussed the instructional methods that science teachers use in their classroom. In this theme, it was found that teachers mostly use a teacher-focused method as their and use demonstration as a way to show students how to conduct experiment. The fourth theme revealed several issues that hindered teachers from implementing the instruction of science effectively by using modern teaching approaches. Those issues pushed teachers to use traditional methods of instruction such as lectures.

Lastly, the fifth theme discovered teachers did not implement inquiry-based approach in teaching science because they were not aware of it. Overall, the themes show how the professional development experience of science teachers of secondary school in Tanzania impact their instructional practices and also, they reveal the instructional approaches that science teachers use in their classroom.

CHAPTER 6

CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND RECOMMENDATIONS

The purpose of this study was to (a) understand how the professional development learning experiences of Tanzanian secondary school science teachers influence their instructional practices, and (b) examine the approaches that science teachers utilize in the classroom, specifically the inquiry-based approach.

Research Questions

1. What kinds of professional development opportunities do science teachers receive?
2. What methods do Tanzanian secondary school teachers use to teach science to their students?
3. How do science teachers come to understand and make sense of what an inquiry-based approach means in teaching science?

This chapter interprets the findings presented in Chapter Five and is divided into five major sections: discussion of the findings, implications for practices, implications for public policy, implications for future research, strengths and limitations of the study. Four conclusions can be drawn about how the professional development learning experiences of Tanzanian secondary school science teachers influenced their instructional practices, and what approaches science teachers use in their classroom, and they are presented below:

Conclusion One: The professional development for teachers is limited, inconsistent, and uneven and does not meet the modern standards of science education.

Conclusion Two: Quality teaching is hindered by government policies that limit access to resources and infrastructure.

Conclusion Three: The Tanzanian science curriculum does not incorporate the inquiry-based approach; therefore, teachers did not implement this approach in their classrooms**.**

Conclusion Four: The encumbrance of teaching science to meet the requirement of the curriculum significantly affects the quality of instruction.

This section discusses these conclusions and explains how each conclusion contributes to the existing research.

Conclusion One: The professional development for secondary school science teachers in Tanzania is limited, inconsistent, and uneven and does not meet the modern standards of science education.

Inconsistent and Limited

During the interviews, the participants shared their experiences and viewpoints regarding the professional development opportunities they received. Five of the participants mentioned that they had opportunities to attend professional development activities. However, they indicated that they had only received such opportunities once or twice during their tenure teaching science and some of them worked at researched schools for 25 years without being offered any professional development.

Four participants reported never having access to professional development since they started working at their schools. Some of these teachers worked for over 10 years and did not have any experience with professional development. At another school, there was only one participant (King) out of the 13 participants who mentioned that he was offered many different professional development opportunities in part because he was a national trainer. Thus, he did not miss any opportunities, because he needed to be trained to be able to train other teachers nationally. King attended numerous seminars and workshops both nationally and internationally.

Uneven

As revealed in the findings, some teachers were able to experience a few trainings while others had not had any opportunities at all, and only one was privileged to have access to numerous professional development opportunities. Based on these findings, clearly, the professional development opportunities were not distributed and provided evenly to the science teachers. As the participants remarked that teachers were selected based on their relationships they had with their school administrators, some teachers had to wait for their turns, which sometimes never came, or teachers had to be popular or known to the individuals involved in the professional development programs. According to one participant named King, he was given access to training because his teaching performance was remarkable.

According to the findings, there was bias in selecting teachers to attend the professional development sessions, and politics were a determinant in which teachers were selected to participate in the professional development opportunities. This finding corresponds to Cervero and Wilson’s (1994) claim that institutional leadership and power relationships have a significant impact on professional development, and these power relationships within the institutional leadership represent their own interests about who to involve in the program and who not to involve (Cervero & Wilson, 1994). Therefore, it is important to understand that professional development programs are directly tied to institutional interests, and those involved represent their own specific interests and agendas in developing the program (Cervero & Wilson, 1994).

As per Corcoran (1995), this lack of participation results from having inequities in teacher access to professional development options. Professional development opportunities tend to be offered to select groups of teachers, and this brings up fair play questions. Corcoran (1995) suggested that policymakers should invest in all teachers irrespective of their backgrounds, motivations, interests, or performance. Therefore, the inconsistency in the provision of professional development can bring up grievances among the teachers, thereby lowering their interests in attending such programs.

Ineffective in meeting the modern standards of science education

Numerous researchers have conducted studies on professional development, but came up with different findings. Some discovered that professional development can be ineffective and negative if it is not interactive, operates under a faulty theory of teacher learning and if there lacks teacher support during the implementation phase (Gulamhussein, 2013). Other researchers found that professional development can be positive and effective when considerable time is spent and the study is well organized, carefully structured, purposefully directed, and focuses on both content and pedagogy (Gulamhussein, 2013; Guskey & Yoon, 2009, p. 499; Wei, Darling-Hammond, & Adamson, 2010). However, the findings of this study found that the professional development programs offered to teachers were not effective, because they lacked features such as coherence, content focus, collective participation, and incorporated activities that were of insufficient duration (Desimone, 2009).

Professional development features in promoting teacher change

Many researchers have found that the following elements are found in successful professional development programs: Firstly, professional development should be continuous, ongoing, and long-term (Guskey, 2000; Quick et al., 2009); However, this study revealed that 12 out of the 13 participants regarded the professional development opportunities as short term. The trainings these teachers had attended were considered one-shot workshops or seminars, which often do not change teachers' practices. This assertion corresponds to Johnson (2006), indicating that one-shot professional development activities do not address the needs of teachers who seek up-to-date approaches and instructional strategies. Similar views were echoed by Dass and Yager (2009), who criticized short-term professional development events and declared that teachers' abilities to utilize strategies that promote active learning cannot be developed through brief, one-shot professional development sessions.

Secondly, professional development should incorporate a teacher's content knowledge/subject matter (Quick, Holtzman, & Chaney, 2009) and pedagogical knowledge (Desimone, 2009; Desimone, Porter, Garet, Yoon, & Birman, 2002; Grossman, Wilson, & Shulman, 1989: Guskey & Yoon, 2009; Nuangchalerm, 2009; Shulman, 1986). This was the opposite of the professional development activities in which the participants were engaged. The professional development options offered to the science teachers focused on syllabus adjustments, how to grade, and how to use improvised laboratory equipment, which did not affect the quality of their teaching. The activities were not customized to the content they taught and the skills they needed to develop. Thus, the professional development activities did not incorporate subject matter (content knowledge) that included knowledge of the subject and its structures (Grossman, Wilson, & Shulman, 1989) or even pedagogical knowledge (general knowledge of instructional methods) in the training (Nuangchalerm, 2009). Thus, the content knowledge and the pedagogical knowledge of the teachers did not have an effect on the teaching practices of these teachers as a result of them participating in the professional development activities offered.

Thirdly, professional development should provide support and feedback (Dass & Yager, 2009; Guskey, 2002; Guskey, 1995). One participant in this study claimed that there was no support or follow-up after the seminar. This act hindered her from being able to apply what she had learned as she got stuck in the middle of class, and she was not able to communicate with or get a hold of the facilitators since the training to ask follow-up questions. As Guskey and Yoon (2009) suggested that professional development should offer follow up activities, it was the opposite for this professional development, because there were no follow up activities as teachers, such as Viola, expected. In order for professional development efforts to be successful, support and feedback are necessary. As Guskey and Yoon (2009) concluded, nearly all of the studies that revealed positive improvement in students' learning involved substantial amounts of structured and continued follow-up after the primary professional development event or activity.

Therefore, the professional development programs in which the teachers participated did not make a lasting impact on the teachers and did not help them to put their learning into practice.

Fourthly, the professional development trainings should offer practical uses, otherwise teachers' expectations will be low (Corcoran, 1995). Compared to Corcoran's assertion, a teacher like Viola could not use her learned knowledge practically. Two other teachers indicated that they could not use or transfer the knowledge they gained through professional development programs they attended into their classrooms, and therefore, they considered these trainings fruitless to their practices.

Fifthly, the professional development should offer incentives to boost participants' motivation to participate (Corcoran, 1995). In this study, participants mentioned that they were not provided with any incentives. Those teachers who had a chance to participate in the professional development events indicated that they were not provided with any bus fare or any kinds of incentives for attending, and even in the workshops, they were not offered any beverages during the whole training. As Craig et al. (1998) asserted, the viability of a teacher development program is intensified not only when there is long-term involvement by stake holders but, also, when there are incentives and rewards. Craig et al. (1998) specified that incentives can be in the form of money payments, food, or transportation. As discovered, the professional development of these teachers did not, in fact, meet the needs of the teachers (Craig et al., 1998), and the teachers' motivation to participate in these activities decreased. Therefore, this study also provided evidence that the aforementioned qualities were important to include in the professional development of teachers. The low frequency of professional development programs offered to the Tanzanian secondary school teachers resulted in a lack of improvement in terms of teachers' instruction in the classroom.

Consequences of the inadequacy of professional development

Overall, the study findings illustrate that the professional development options for science teachers were not adequate for enabling teachers to learn new instructional methods effectively and to implement such methods in their classrooms. Thus, teachers still used the traditional ways of teaching, because they were not informed of and knowledgeable about appropriate innovative teaching methods.

Holly and McLoughlin (1989) indicated that there are professional development programs which occur under the auspices of school and those which are individually directed. In this study, apart from the professional development offered and supposed by the government, there were individually guided programs that teachers attended. These teachers self-directed their own education opportunities, seeking professional development through higher and continuing education. These teachers decided to go to school, because they wanted to have a sense of accomplishment and greater job satisfaction (Oreopoulos & Salvanes, 2011). According to the study findings, the participants recognized the need to advance their careers by obtaining a university degree, so they went beyond the call of duty to continue their education and earn their bachelor's degrees.

One participant stated that technology is constantly changing, so enrolling in continuing education not only provided her with the tools she needed to incorporate technology in the classroom but also allowed her to acquire knowledge, which helped her apply the lessons in her daily life. Oreopoulos and Salvanes (2011) asserted that schooling creates many experiences and affects multiple dimensions of skills and, as a result, may affect central aspects of individuals' lives both in and outside the labor market. These opportunities were available for teachers, but their schools were not financially supportive; they helped in other ways for instance, allowing them to take off days and take a leave from school. These teachers were satisfied with the knowledge, skills, and other attributes they acquired as a result of their higher education.

Learning Communities

Finally, there were other findings that emerged as a result of this study. It was discovered that participants had a support system among themselves; they met to discuss ideas and share knowledge with each other. Egodawatte, McDougall, and Stoilescu (2011) asserted that collaboration offers teachers professional development opportunities such as co-teaching, co-planning, and many other positive experiences. A few teachers also organized meet-up groups for the purpose of supporting and sharing expertise, experience, and resources. In Daly, Moolenaar, and Burke's (2010) study, they found that teachers who collaborate have better abilities to access and make use of their peers and shared resources entrenched in their professional network. The resources in this case were the knowledge, skills, and experiences of the teachers. The experiences shared by the participants in this study reflected mostly positive encounters with their fellow teachers, and a majority of the teachers affirmed that being part of a community was useful.

Lieberman and Mace (2008) indicated that learning is a social activity, and it occurs through experience and practice. Individuals learned from and with each other in many different ways, including through their communities (learning in the acts of participating and being with each other). Thus, participating in these informal gatherings as a learning space for science teachers not only enhanced their confidence in teaching topics they considered difficult, but it also strengthened the relationships they had with one another. These learning activities assisted both experienced and less experienced teachers as they had the opportunity to informally train or model each other on particular topics or practices. This kind of 'collaborative' learning resulted in fellow teachers applying the discussed and practiced exercises in their own classrooms. The term "collaboration," in this case, refers to teachers' cooperative actions (in doing tasks together) for job-related purposes (Kelchtermans, 2006, p. 220).

According to Quick et al., (2009), sharing learning experiences with peer teachers at schools promotes collective support and reflection over time. Notably, in this study, teachers' collective experiences in their discussions, class observations, and moral support for each other somehow increased their confidence and improved the teachers' abilities to teach the topics that they regarded as difficult without obtaining any incentives, rewards, or support from the government. Most of the participants cherished these collaborative relationships and the support they built assisting each other in uncovering challenges in their teaching practices and responding in supportive and constructive ways. This corresponds to Lieberman and Mace's (2008) assertion that regardless of who the organizers are, be it a group of teachers, a department, team or group of schools, the notion of teacher communities has been incorporated by educators all over the world as a way of meeting the challenges of enhancing schools in this fast-paced and challenging global society.

On the other hand, there are numerous obstacles and limitations that made it difficult for teachers to engage in interactions or collaborative work to construct new insights into their teaching problems and to foster instructional innovations (Egodawatte at el., 2011). It was found in this research that not all science teachers supported or helped one another. Some teachers did not work very well with others for different reasons. For example, there was no communication amongst the science department. Each of the departments (Chemistry, Physics and Biology) worked independently. Due to a lack of teachers, at times, the teachers were asked to teach different subjects other than their specialized subjects. For instance, a biology teacher would be asked to teach physics and so on. Thus, at one point, these teachers worked together, but once in a different unit, they stopped communicating with the other units outside of their own.

Brownell, Adams, Sindelar, Waldron, and Vanhover (2006) affirmed that opportunities to work together with teachers do not always result in the same learning outcomes; teachers may profit more or less than others from collaboration. This corresponds with the findings of this study in that not all teachers benefitted equally in the organized meetings. A few teachers felt that even if they had difficulties with their instructional practices, it was not worth asking their colleagues, because they thought the teachers lacked competence in their teaching areas, so somehow, they were going to be given the wrong information. This translated to a lack of trust among teachers, as they did not feel comfortable expressing their concerns to their peers.

Therefore, the participants in this study relished the opportunity to dialogue with each other and exchange some ideas, sharing practices, challenges and experiences. However, this collaboration did not work for all participants, because there was a disconnect among teachers due to different reasons such as a lack of communication, time and trust, and a lack of communication can create tension that restricts a positive collaboration process (Holly & McLoughlin, 1989). Additionally, the science departments were separated, and this made it difficult to make connections with other science units.

When teachers work together to achieve a common goal, they are able to change their instructional practices in important ways (Brownell et al., 2006). Overall, in this study, the teachers benefited from working collaboratively with one another. They provided support to one another and shared knowledge, especially when in need. However, while some teachers made the effort to work with others and sought assistance from others, some preferred working in isolation and managed their work independently, and thus exercising a culture of individualism (Kelchtermans, 2006).

If these learning communities are perceived as the best professional learning for teachers, then support can be offered to these teachers to encourage them to develop and, in the process, generate the conditions for more open and collaborative school cultures (Lieberman & Mace, 2008). Therefore, school administrators, educators and leaders should not overlook the power of collaboration and peer-support activities as it can reduce teachers' ambiguity regarding the science topics and, ultimately, improve their ability to perform their jobs effectively.

Conclusion Two: Quality teaching of secondary science teachers in Tanzania is hindered by government policies that limit access to resources and infrastructure.

Lack of practical work due to limited resources and infrastructure

Per the study findings, teachers were inhibited by Tanzanian governmental resources and infrastructure, and this hindrance significantly affected the teaching practices of the teachers. Some of the barriers discovered in the provision of quality science education in Tanzania included: large class sizes, insufficient teaching and learning facilities (science labs and libraries), inadequate supplies of chemicals, scant teaching and learning resources, few qualified science teachers, and antiquated pedagogical approaches. For instance, participants stated that they believed integrating science laboratory activities would help students gain a greater understanding of science concepts and processes; however, they acknowledged that some of the previously-mentioned challenges restricted them from conducting laboratory work.

All participants identified the lack of teaching and learning resources as a constraint, and therefore, most of the participants specified that they rarely conducted science experiments in the laboratories because of the large number of students, nor did they incorporate very many practical activities through demonstrations in their classrooms. As Tobin (1990) stated:

> …meaningful learning is possible in laboratory activities if all students are provided with opportunities to manipulate equipment and materials while working cooperatively with peers in an environment in which they are free to pursue solutions to problems which interest them (p. 414).

The participants recognized the importance of carrying out practical work; however, they admitted that they skipped experiments due to various limitations, including preparation time, a lack of laboratory resources, and a shortage of physical laboratories. Teachers could not allocate time for students to conduct laboratory activities, and the students rarely interacted during the demonstration work although research has determined that meaningful learning in the laboratories occurs when students are offered adequate time and opportunities to interact and reflect (Gunstone & Champaign, 1990). Thus, the demonstrations that teachers conducted in lieu of using the laboratory in this study were not effective for positively affecting students' understandings of science content knowledge.

Laboratory resources play an important role in the teaching and learning processes of science subjects. As in Tobin's (1990) statement above, students are supposed to engage themselves in the learning process and use tools interactively with their peers to construct knowledge and make it meaningful. However, this was not the case in three of the four researched schools, as the participants indicated that not all students had the opportunity to use the laboratories for experiments. The highest priority for conducting experiments was only given to the students who were approaching their final examinations. The findings discovered that through step-by-step demonstrations, experiments were conducted occasionally in the classrooms, and students were not given opportunities to interact with their peers or with the equipment. This denotes that by the time the students completed their secondary school education, they would have had little (if not any) experience interacting with learning tools in science laboratories. As indicated by Hofstein and Lunetta (2004), science laboratory activities allow students to interact with materials and with models to observe and understand scientific concepts.

In terms of who had the most access to the laboratory, form II and form IV students were privileged. The teachers' desire was to teach practical skills to all students from form I through form IV students; however, they focused only on form II and form IV students for conducting experiments due to the limited laboratory equipment and chemicals. They were forced to put a higher priority on these students, because they were approaching the dates for the national examination. The insufficiency of laboratory materials clearly caused the issue of rote learning, which is connected to copying notes from textbooks. In this style of teaching, students memorized and were passive learners, because they did not get the opportunity to practice and conduct experiments other than being lectured.

The participants in this study had little experience with or knowledge of organizing laboratory activities. Four participants mentioned that their schools did not provide laboratory assistants any longer, so teachers had to prepare the experiments on their own. For instance, one teacher, Theodora, was incensed that the teachers had to serve as both teachers and laboratory assistants. She stated "*Taking into consideration that we do not have lab technicians in our government schools at the moment, you are a teacher; you are a lab technician; you are everything. Now, how are you going to prepare this without experience?"* Therefore, not only was the lack of chemicals, equipment and physical laboratories a hurdle, but the lack teachers' experiential laboratory knowledge was another obstacle discovered in the findings.

The lack of laboratory equipment and shortage of physical laboratories in this study made teachers acknowledge the importance of experiments in teaching science in theory yet face the reality of rarely implementing them in practice. Teachers rarely took students to the laboratories, because the laboratories were not big enough to accommodate large numbers of students, and also, most of the laboratories were not equipped with chemicals. As a result of this problem, the laboratory activities were conducted by teachers through demonstrations. However, even demonstrations were infrequently performed.

Although this issue with resources was difficult for these teachers to handle, I believe that the participants sometimes used the lack of resources as a rationalization for failing to teach effectively. Basically, they largely imagined that they could not have taught effectively without having sufficient resources. In other words, they were self-imposing limitations instead of striving to be creative and resourceful teachers. Knowing that the government could not furnish the schools with enough resources, teachers could have made the most of the class activities using the few resources that they had on hand to make learning relevant for the students instead of depending on the government to provide the resources.

The laboratory work these teachers conducted in the classrooms through demonstration were not as effective, because the teachers basically showed students how to conduct certain experiments, but the students did not practice or use learning tools to make meaning of the science lessons. Vygotsky's (1978) believed that learning cannot be separated from one's social context, and a person develops or learns through active engagement with others within a specific sociocultural context. It is not only the social context that creates new understanding, as human actions and interactions are mediated by tools and signs. According to Vygotsky (1978), these teachers' practices did not support the sociocultural learning. Student learning probably did not take place because, as Vygotsky noted, learning takes place in social interactions between individuals and also as individuals interact with other resources that are accessible in the social setting.

The practical activities were teacher-centered and can be considered ineffective and impractical as students were not engaged in the learning of constructing knowledge, instead they remained passive listeners and observers. This kind of science teaching does not correspond to Tobin's (1990) assertion in that "laboratory activities appeal as a way of allowing students to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science" (p. 403). Teachers need to aid students in the understanding that science is an everyday practical experience and not merely a set of scientific procedures and activities with no relationship to real-life (DomNwachukwu & DomNwachukwu, 2006).

As mentioned above, due to the poor funding of the education sector, teachers were not supplied with adequate resources to assist them with their instruction. However, teachers discovered other ways of conducting experiments by using locally made equipment, a process called "improvisation." In the absence of ideal tools, for instance, a teacher can use a locally available tool as a replacement (Owolabi & Oginni, 2012). In this study, when there were not an adequate number of beakers, participants infrequently used bottles of water in place of beakers. For those participants who had an opportunity to attend professional development trainings, they were taught how to use locally available tools as substitutions. However, upon returning to their home schools, there were no funds allocated to even purchase the improvised tools. Since participants' salaries were low, they were definitely against spending their own money to buy the materials to create the tools, and at times, they asked students to bring items from their homes.

According to Owolabi and Oginni (2012), improvisation is important, especially in the absence of ideal equipment, and serves the following purposes in the education system: 1. It reduces the money spent on the purchase of equipment; 2. It helps in solving the problem of the lack of equipment; 3. It allows teachers to demonstrate their creative skills; 4. It provides an opportunity to apply cheap local materials as alternatives in the absence of expensive foreign ones; 5. It promotes the development of creative abilities in students; 6. It strengthens inquiry and investigative methods in the sciences; 7. It enables teachers to think about cheaper, better, and faster methods of making the learning process easier for students, and; 8. It gives students the opportunity to interact with and become familiar with resources in the classrooms. With all these benefits of using cheaper teaching equipment, the government still could not allocate funds to the education sector to buy the improvised materials for the teachers. Although the teachers recognized that they could use improvised teaching aids, they did not put effort into using such tools due to financial restrictions.

The findings of this study discovered that the availability of laboratory equipment is vital for the effective teaching and learning of science. All the participants I observed and interviewed remarked that teaching and learning science entails all senses: touching, seeing, smelling, etc. Thus, laboratory equipment not only allows the teacher to conduct experiments in the laboratory, but also, students get a chance to conduct experiments individually or in small groups to verify scientific theories and formulas. According to the participants, most of the science topics require the incorporation of experiments and practical activities, and therefore, laboratory equipment would be necessary to achieve this objective.

In summary, in light of the deficiencies in the teaching resources and facilities, when considering the development of science education from a historical perspective, it can be noted that science education has faced challenges for a long period of time. The lack of resources has always been and continues to be an issue, and it significantly affects the way science is taught. Evidently, there is an undeniably gap between theory and practice, and this disparity appears to be the norm in the cultural context of Tanzania science education, especially when one revisits the historical perspective of science education in Tanzania.

Large number of students

According to the findings, most of the classes in the secondary schools had large numbers of students. Two or more classes were joined into a single room to ensure that students learned the subjects for the scheduled number of hours per term. This issue affected both the possibility of implementing group work with the students and interactions between the teachers and their students. As asserted by Finn and Achilles (1999), class size is a vital attribute of the setting in which teachers teach and students learn. The interaction between a teacher and his or her students can be restricted by the class size (Finn & Achilles, 1999). Even the amount of attention given to each student and the individualized instruction can be limited due to the number of students in the classrooms (Finn & Achilles, 1999). This statement corresponds with and is relevant to the class observations I conducted; interactions between these teachers and their students were lacking and, thus, affected the quality of instruction.

Therefore, when a class size is large, teachers not only have little interaction with their students, but also, students have little interaction with their peers, which makes class management difficult and decreases the ability for effective teaching and learning. Although the Tanzanian government is striving to upsurge the enrollment of secondary school students, it is also imperative to be aware that accepting all these students while the physical classrooms are not adequate affects teaching and learning negatively. A large number of students would normally translate into adding more teachers, building new classrooms to accommodate the number and adding more laboratories and equipment to accommodate all students in conducting experiments as necessary. However, if all these factors are not taken into consideration, the quality of education yields undesirable effects.

Lack of active learning

Another challenge that came up as a result of the large classes was the use of group work. Participants stated that it was difficult for them to put students in groups, because it would take a long time to work on one task. Blatchford, Baines, Kutnick, and Martin (2001) echoed this when they asserted that in a small class, there were more opportunities for individualized and very small group work and individual attention.

Student engagement was lacking, because the teachers acted as information transmitters, and they were the only ones speaking. Students only spoke when they were answering questions and had been permitted by the teachers to communicate. This corresponds to Blatchford, Bassett, and Brown's, (2011) findings, indicating that larger classes can lead to students accepting a passive role in the classroom. As found by Blatchford, Bassett, and Brown, (2011), class engagement is vital as it permits the interaction between teachers and students. Teachers' opportunities to engage the students and keep them on task were limited. In order for learning to take place, there should be interactions (Vygotsky, 1978), but this study's findings indicated that teachers did not give students the opportunities to share their understandings with their peers to construct their knowledge thusly; therefore, it could have been difficult for them to create sensible explanations for the concepts taught.

The teachers believed that working with large classes reduced the amount of time they could be spent on better instruction and dealing with students individually. These teachers did not serve as facilitators and did not help students construct knowledge on their own. Thus, they did not follow the sociocultural principle which states that a teacher should act as an expert and facilitate learning within learners' zones of proximal development (ZPD) by assisting and guiding learners in attaining competence in the skills and knowledge valued by a society (Vygotsky, 1978).

Lack of motivation due to poor service conditions

Moreover, this study uncovered that the teachers were unmotivated due to various conditions in the workplace; as a result, they placed less concern on the learning needs of their students. Participants articulated that there was no motivation for teaching science subjects. The lack of motivation arose from various factors, which had a negative influence on these teachers' performance. These factors were: poor working conditions, remuneration packages, handling large class sizes, being overworked, which resulted in a shortage of teachers, and teachers' incompetency. Being poorly motivated, teachers found it difficult to fully engage in the teaching process, and this may lead to undesirable science educational outcomes.

Salifu (2014) described teachers' working conditions as a necessary environment generated for teachers at their workplaces to motivate them to greater performance. These working conditions include classroom space, electricity, appropriate class size numbers, availability of enough furniture, teaching and learning materials, and competitive remuneration and incentive packages. All of the aforementioned conditions listed by Sanifu (2014) emerged in this study as deficiencies, and in one form or another, restricted participants in this study from teaching successfully. Teachers experienced unfavorable work conditions, which negatively affected their teaching process. Therefore, the Tanzanian government should strive to improve teacher well-being and motivation so as to ensure quality instruction in the science classrooms.

Low salary, class management issue, and overworking

The participants were mostly worried about how and where they could obtain additional money to meet their daily needs. At one point, participants were not concerned about students' failure, because they always reflected on their remuneration and the workload they had. The teachers taught quickly and engaged in tutoring services outside of school to earn additional money. Clearly, this implied that the teachers had a low level of satisfaction, and that negatively affected their teaching practices. The effectiveness of a reward system positively motivates employees to fully attend to doing a good job (Adil & Neelam, 2013). These teachers were frustrated knowing that they were giving their best efforts to teach students, but in return, they did not receive adequate compensation. As Adil and Neelam (2013) explained, an appropriate rewards system reinforces competitive performance, which includes remunerations, salary, wages, and supportive working conditions.

Therefore, the findings of this study discovered that poor workplace conditions such as low salaries, being overworked, and classroom management difficulties contributed to teachers' low motivation. Due to these factors, the participants indicated that they could not perform their work effectively, because they had a low level of satisfaction. Four participants specified that their salaries were so low to the extent that if they had any family emergencies, they would not have managed to solve them in any way. Participants mentioned that their daily workload was so heavy, but the salaries were very low, and there was not a compromise between the two. Two participants expressed how they felt about the remuneration issue, stating that they did not even pay full attention in class, because they were not content. Clearly, these teachers were not motivated, because their needs were not met. Adil and Neelam (2013) pointed out that even when teachers are faced with financial and social constraints, motivation gives them energy to perform their jobs better.

Conclusion Three: The Tanzanian science curriculum does not incorporate the inquiry-based approach; therefore, teachers did not implement this approach in their classrooms.

Unawareness of Inquiry

There are four levels of inquiry activities that differ as per students' levels of independence (Banchi & Bell, 2008). These levels included confirmation, structured, guided, and open-ended inquiry; all of these levels should build upon each other (Banchi & Bell, 2008).

According to the findings of this research, secondary science teachers in Tanzania were not aware of the inquiry-based approach. None of the participants indicated that they understood the inquiry-based approach to teaching science; consequently, they did not implement inquiry-based activities or use any of the abovementioned inquiry levels in their classrooms.

Some participants mentioned that they did not know how to teach certain topics, thus were lacking science content. Many researchers affirmed that a lack of science content knowledge can create difficulties for teachers when implementing inquiry-based lessons. Teachers need to develop their understanding of scientific inquiry before they instruct students to understand and apply inquiry processes. Pedagogical knowledge is also required by science teachers; otherwise, lacking this knowledge can lead to a teaching challenge as indicated by Shulman (1986). Since these teachers did not know or understand what the inquiry approach was, and some had never heard about the inquiry-based approach, they were probably incapable of implementing this approach in their classrooms.

Project as Inquiry

After I explained what the inquiry-approach meant, the participants misunderstood this approach, describing it as a "project." Most projects took place outside of the classroom, and none of the participants mentioned that the activities involved in the projects began with a scientific question and that students analyzed the data they had collected. Students might have gone outside of their schools to conduct research as a requirement for their projects or even to perform hands-on activities; however, this did not mean students were applying the inquiry-based approach, because their activities did not involve research questions or even data analysis.

Thus, their project efforts did not qualify as inquiry activities. Bell, Smetana, and Binns (2005) indicated that numerous hands-on activities performed in science classrooms do not involve a research question or data analysis. This confirms that the projects conducted by secondary students in Tanzania are different from the inquiry-based approach, because inquiry-oriented activities must begin with a scientific question and must engage students in analyzing relevant data. Therefore, involving students in a hands-on investigation does not signify an inquiry lesson (Bell et al., 2005).

Teachers alleged that even if they knew the inquiry-based approach, they would not have been able to implement it in their classrooms due to some constraints they were facing. These included time limitations, too much curriculum, classroom sizes, management problems, and limited resources. This corresponds to the literature, indicating that the inquiry-based approach offers compelling opportunities for science learning. However, there are many challenges that teachers face when deciding to teach using the inquiry-based approach (Edelson, Gordin, & Pea, 1999). According to Cheung (2007), teaching through inquiry-based instruction in science remains difficult for teachers. Cheung specified different barriers that teachers must overcome to be successful inquiry-based teachers, and these barriers complement what the participants stated. These barriers include the lack of effective inquiry materials, lack of time, pedagogical problems, large classes and management problems, and material demands.

Cheung (2007) indicated that inquiry-based instruction and experiments require more time than traditional approaches (Cheung, 2007). Most of the participants claimed that time was limited for conducting their normal teaching which would have made using the inquiry approach all the more restrictive, because inquiry-based instruction would have been time consuming for covering the same curriculum (Mumba et al., 2015).

In terms of materials, all participants stated that their schools had inadequate teaching and learning materials. As per Cheung (2007), teachers have difficulties locating inquiry materials, because cookbook-style laboratory activities are very popular on the market, while inquiry-based materials are limited and hard to find (Cheung, 2007). For teachers, this means they need additional time to plan their own inquiry-based lessons (Mumba et al., 2015). Thus, implementing inquiry in an environment which lacks teaching and learning materials would be very challenging. The participants mentioned that they did not have sufficient laboratories, equipment, and chemicals. This is another factor which prevented these teachers from implementing the inquiry-based approach. As Cheung (2007) asserted, science teachers perceive the demand for materials as a drawback to implementing inquiry-based laboratory activities, because there is a prevalent need for adequate supplies of equipment and chemicals in school laboratories. At times, in inquiry-based instruction, the number of chemicals used is much greater than in a traditional laboratory (Cheung, 2007). If the participants had rarely conducted traditional laboratory activities, because they lacked equipment and had a shortage of laboratories, it would have been extremely difficult for them to carry out inquiry laboratory activities.

In regards to class management and the large class sizes, most of the participants mentioned that they taught very large classes. As Cheung (2007) noted, it can be a challenge to implement an inquiry-based approach in a large size class, and this is even harder when conducting laboratory activities through inquiry. The participants specified that two to three classrooms were combined to form one; thus, it would have been challenging to manage an inquiry classroom in this environment. This assertion is supported by Harris and Rooks (2010) who claimed that “enacting inquiry-based instruction requires a different kind of approach to classroom management that takes into account the close-knit relationship between management and instruction” (p. 227). It is challenging to manage an inquiry classroom (Cheung, 2007; Harris & Rooks, 2010). It is essential to examine the difficulties that teachers encounter in managing students and promoting scientific practice through inquiry; this might include issues, such as instructional materials, the general classroom community, tasks, and science ideas (Harris & Rooks, 2010). Therefore, based on participants’ remarks regarding the classroom settings, implementing an inquiry-based approach would have been a difficult practice to carry out.

Non-Inquiry Classroom

There were no opportunities designed for students to incorporate theory and practice in this study, and students were not offered activities that would have allowed them to apply the lessons they had learned and solve real life problems. This kind of classroom practice, where students remained passive and memorized materials, evidently revealed that the inquiry-based approach was not applied in schools funded by the Tanzanian government. The science curriculum may not accomplish its intentions of producing enough future doctors, researchers, engineers, and scientists if the inquiry-based approach, whereby students gain problem-solving skills and become independent thinkers, is not promoted and used.

Conclusion Four: The encumbrance of teaching science to meet the requirement of the Tanzanian curriculum significantly affects the quality of instruction.

Pressure to meet curriculum requirement

This study discovered that one of the major constraints in the teaching of science was the emphasis put on teachers to complete the syllabus. Basically, there was a disconnect between government policy and education practices. Out of the 13 participants, 12 stated that they were pressured to meet the requirements of the curriculum. This pressure caused other teaching challenges, which impeded teachers from implementing good practices in their classrooms.

First, participants indicated that due to the pressure put on them to complete the syllabus, they opted to use a lecture-based method because of time limitations. In order to finish the syllabus on time, a teacher-centered approach was the best teaching method for these teachers, because it did not require much time as compared to a student-centered approach. Thus, lecturing was the cheapest and easiest teaching method for Tanzanian teachers, because they did not have to put students in groups to interact or work cooperatively. Lecture is considered ineffective as an instructional method for student learning (Omelicheva & Avdeyeva, 2008). Many educators maintain that lectures are ill-suited to promoting higher order cognitive skills (Omelicheva & Avdeyeva, 2008). In lecture classrooms, students are passive and engaged in extensive note-taking (Omelicheva & Avdeyeva, 2008). This style of teaching supports rote memorization in students and does not promote accurate and complex conceptual model development or problem-solving skills (Miller, McNeal, & Herbert, 2010; Omelicheva & Avdeyeva, 2008).

The participants acknowledged that the student-centered approach was an effective method for teaching science; however, if they used a student-centered approach, they would not have been able to complete the syllabus because of the following reasons. First, preparing class activities would have taken most of their time. Second, putting students in groups and permitting students to work collaboratively would also have taken a great deal of time due to students' differing levels of abilities. As these teachers noted, some students were faster learners, and others were slow learners; therefore, assigning work to students to perform with their peers was regarded as a drawback, because teachers would not have been able to finish the topics they needed to cover for that particular day's lessons. In other words, before going to class, if teachers had already planned that a certain topic must be covered that day, then they were assured that through lecturing and notes they would accomplish their goals. This was an unsuccessful technique, though, because it indicated that they did not consider the needs of students in terms of how they consumed and comprehended large amount of information all at once. This concern is reiterated by Berry (2008) in that students consider the content dull and confusing, and they are overwhelmed when teachers lecture to cover large amounts of information over a short period of time.

Teachers taught students merely to pass the national examination, and this was another challenge that was derived as a result of the emphasis on curriculum. This study discovered that the objective of the science curriculum focused on the preparation of students to pass their national examinations. By the time students sat for their final examinations, teachers must have completed teaching all of the topics covered in the syllabus. Although the science syllabus was overloaded with many topics, teachers strived to cover them in a respective allocated period as required so that their students would obtain good grades at the end of their ordinary or advanced level secondary schools.

The results of this study showed that science instruction was mainly conducted theoretically, promoting a teacher-centered approach. The students were passive listeners as the teachers did not engage them in the learning process. Kazempour (2009) affirmed that science teachers need to guide and facilitate learning and students must take an active role in constructing their own knowledge. This was an ineffective way of teaching science subjects, because the practical aspects of the lessons were almost absent. Berry (2008) asserted that lecturing as a method lacks the effectiveness of an active learning method. Instead, the teachers focused on presenting formulas and equations, and they infrequently organized practical activities. It was evident that the teachers did not apply instructional methods to help their students develop a basic understanding of scientific principles with clear, creative, independent and logical thinking. One challenge of the curriculum is that teachers do not know how to teach self-direction, collaboration, creativity, and innovation the way they know how to teach long division (Rotherham & Willingham, 2009, p. 20). As a supporter of active learning, Kane (2004) suggested four qualities of active learning which resemble the modern teaching methods such as the inquiry-based approach that Tanzanian science teachers did not implement in their science instruction: (1) seek to encourage independent, critical thinking in students; (2) encourage students to take responsibility for the lessons they learn; (3) engage students in a range of open activities such as discussions, role-play etc. so that students play a less passive role in the transfer of knowledge, and; (4) organize appropriate learning activities in which students can explore and develop their knowledge base and thinking. In addition to the above qualities, an environment of collaboration is required for active learning to be effective and efficient (Berry, 2008)

Therefore, the primary method of instruction at the researched schools was lecture-based, which promoted memorization and recitation. This kind of instruction did not prepare students for practical living within the society as well as for higher education. Teachers used methods that were not useful for making students capable of applying scientific knowledge to their everyday problems or situations.

Implications for Public Policy

This study was conducted to investigate ways to contribute to the overall improvement of science teaching and learning in Tanzanian ordinary level secondary schools. Findings from this study are relevant to the Tanzanian context, particularly for enhancing the quality of science education in ordinary level secondary schools. The study therefore proposes the following recommendations for public policy:

Curriculum

Tanzanian science education requires major changes in how students are taught science. The government should reduce the emphasis on national examinations, because this results in a reliance on didactic teaching approaches, whereby teachers simply become the transmitters of information to students. The traditional and didactic model of instruction still dominates instruction in classrooms (Roehrig et al., 2012). The manner in which science is taught leads to rote memorization and the cramming of formulas, representing low-level thinking. This instructional strategy does not promote or develop problem-solving skills, because students are not given the opportunity to investigate reason or organize knowledge (Miller et al., 2010).

Instead, the national examinations should be developed to incorporate higher-level thinking and problem-solving skills, which can play a valuable role in promoting critical thinking and understanding. Rotherham and Willingham (2009) asserted that "Without better curriculum, better teaching…the emphasis on "21st century skills" will be a superficial one that will sacrifice long-term gains for the appearance of short-term progress" (p. 20). Instructional effectiveness is restricted by the quality of the curriculum (Marshall & Smart, 2013).

In addition, the curriculum content should be revised and reduced, and additional time should be allotted to the program or schedule for science teaching. By doing so, teachers may have sufficient time to engage students in experiments and practical activities that would promote active discussion and build students' problem-solving skills. Moreover, the science curriculum should be revised, and inquiry-based instruction should not only be emphasized but actually must be applied in the classroom rather than using didactic and teacher-oriented methods.

However, it is critical to remember that guiding a classroom through planning, implementing, analyzing, and evaluating inquiry investigations requires teachers to have sufficient expertise, content knowledge, and self-confidence to be able to maneuver through multiple potential barriers (Roehrig, et al., 2012). In order for this change to move beyond the administrator's office and penetrate classrooms, it must be understood that professional development is a massive undertaking (Rotherham & Willingham, 2009, p. 20). In order to acclimate to all these changes, educational institutions have to recognize that innovation is imperative and persists. It is necessary to develop new and innovative instructional practices as well as strategies (Moolenaar, Daly, & Sleeger, 2010).

Continuing Professional Development Opportunities

Teacher professional development has been a constant focus for promoting educational reform (Corcoran, 1995). Based on participants' shared experiences, it is recommended that the professional development practices for science teachers in Tanzania be reformed. In order to have an adequate number of qualified, knowledgeable, and motivated science teachers to enhance the quality of science in Tanzanian schools, professional development is key to meeting this demand. Kazempour (2009) supports this notion, stating that teachers must receive professional development so as to bring changes in their views regarding teaching practices that improves the students' learning experiences in the science classroom.

Therefore, science teachers should be provided with professional development opportunities and be supported and encouraged to participate in professional development activities with the ultimate goal of learning contemporary science teaching methods, improving their teaching skills, and acquiring a broad knowledge of how students learn science. Lieberman and Mace (2008) asserted that professional development should focus on instruction and be sustained and continuous, rather than short term and irregular. Thus, teachers' professional development for secondary school teachers in Tanzania should be continuous, relevant, and supported by adult learning theories. Teachers should be given support in light of resources to help in the construction of knowledge of professional development and through policies as well.

Importantly, the professional development should incorporate active engagement, provide feedback and follow-up, and build discourse.

Therefore, the government should make an effort to provide professional development options for science teachers in order for them to gain the knowledge necessary for teaching science effectively. Professional development opportunities should be provided and distributed equally to every science teacher to prevent bias. Teacher training institutions should be intensified to effectively respond to teachers' needs and demands. Learning opportunities for continuing the professional development of science teachers should be generated and utilized to its utmost.

Curriculum developers and professional development leaders can consider constraints that teachers face in implementing the inquiry-based approach and help them overcome these constraints through participating in professional development activities that integrate inquiry lessons. The provision of such opportunities would allow teachers to be trained and learn modern methods of teaching science such as the inquiry method.

According to Hall and Loucks (1978), professional development for teachers should be job-embedded, making it applicable and authentic. It must be relevant and address the specific needs and concerns of teachers (as cited in Guskey, 1995; Quick et al., 2009). Thus, it is critical for professional development developers and designers of science teachers' professional development to take into consideration entrenching these curriculum development materials into professional development trainings for these science teachers. Importantly, both content knowledge and pedagogical knowledge should be incorporated into teachers' professional development. The Ministry of Education and Vocational Training, which manages the provision of in-service training, should incorporate features that constitute effective professional development. The professional development should be continuous, ongoing and long-term, and should provide feedback and promote collaborative interaction.

Change is not easy, and even attending training sessions to learn new innovation involves the adjustment of several different aspects of professional practice in iterative manner. Fortunately, for many years, CBAM has provided information and guidance to professional developers and other school leaders to be familiar with and apply when participating in and facilitating change efforts in their schools (Hall & Hord, 1987). The CBAM is a useful model for examining reaction to change, especially in educational contexts. The implementation of educational innovation can have a profound impact on the success or failure of an initiative. Therefore, CBAM can be employed to address change implementation by pinpointing and analyzing teachers' concerns in facilitating the change process whereby insuring successful implementation. This model is useful and can aid change facilitators in understanding the process of change, how teachers respond to change, and the steps that would insure appropriate actions are taken in making sure the change initiative is a success.

I believe that this model is useful to consult when planning professional development opportunities because it helps expound the way the process of change works for teachers as it offers insights regarding where teachers are in the change process by focusing on the kinds of questions they ask and concerns they communicate. However, the CBAM model was not applicable for this study due to the insufficient professional development offered to teachers and also, the irrelevance of the lessons incorporated in the professional development sessions. Basically, teachers did not experience any change that had required them to use the CBAM model. However, this model can be used in the future to examine the stages of concern and level of use of the new science instructional practices, new science curriculum, or related innovation in secondary schools in Tanzania

In using this model, there must be clear and open communication as well as the recognition of the concerns and questions that teachers have during the change process in promoting innovations. Overall, CBAM continues to be utilized in educational settings; its tools are beneficial in helping the educators, change facilitators, and program evaluators understand, assess and guide the process of implementing new and innovative practices. It will be useful that the basis of the Tanzanian science teachers' concerns about implementing new instructional practices and/or curriculum reform be examined so as to understand how intense the teachers' concerns are and how teachers deal with stress and expectations deriving as a result of the initiation of the new curriculum or instructional methods.

Program Planning

This study highlights the key roles that professional development planners play in the design and implementation of professional development. Professional planners should strive to assure that professional development is of high quality and focuses on the needs of teachers, ultimately attending to students' learning needs. As indicated in this study, professional development programs can be useful; however, they are not the kinds of professional development teachers desire. This disparity may have derived from failing to consider key principles of adult learning theory in the professional development offered to teachers and failure to using an appropriate program planning model. According to Caffarella (2013), the Interactive Model of Program Planning is a useful and practical tool; the program planners have made three major observations about its use in practice: (1) Among arrays of models, this particular model describes activities to be undertaken and provides specific practical suggestions for how to address each component; (2) The interactive nature of this model reflects how program planners practice and thus confirms that they are applying good principles in planning programs, and for others expands their thinking regarding what the planning process; (3) The model helps experienced practitioners in framing education and training sessions for their staff and other planning groups. The model had been utilized by both new and experienced practitioners from different sociocultural backgrounds and individuals have been able to adapt it to their specific contexts.

By acknowledging the needs of teachers, incorporating principles of adult learning theory, and using the Interactive Model of Program Planning into the design, the educational programs may align with the needs and interests of teachers who are diligently seeking effective and relevant professional development opportunities. By doing so, the program planners will meet the immediate needs of individual teachers so that they can indeed inspire their students toward success.

Teacher Motivation

With regard to teacher motivation, the government should appraise teachers' salaries so as to improve teachers' morale at work. Also, an adequate number of qualified teachers should be available for the teaching and learning process to be implemented successfully. Doing this would motivate them to teach effectively and give their best to their students. In addition, proper incentives should be granted to teachers when applicable, and the school's environment should be made safe, suitable, and comfortable by equipping it with adequate furniture, such as chairs and tables. The government should create retention programs so that passionate and dedicated teachers do not vanish from the science education field and leave for better-paying jobs.

Laboratories and Equipment

Science educators place great importance on laboratory work, maintaining that scientific knowledge cannot be effectively learned from books (Atkinson, 1990). In this study, the unavailability of laboratory resources and shortage of laboratories hindered teachers from effectively engaging their students in practical scientific inquiry. Therefore, there should be an increased allocation of funds to build new classrooms and laboratories so as to reduce class size and enable teachers to conduct experiments. Since science subjects are laboratory-based, adequate equipment and materials must be available to allow for teachers and students to perform experiments by demonstrating and validating the theories learned in the classroom. According to Atkinson (1990), a personal involvement in practical work helps students acquire expanded scientific knowledge and develop technical skills, so it is fruitless to learn science without conducting laboratory work. There seems to be reason to believe that many students in science classes feel that the lessons they are taught in these classes have no relevance to their everyday world (Gunstone, & Champagne, 1990).

The Ministry of Education should allocate more funds specifically for the purpose of purchasing equipment, and those funds must only be spent on equipment. Sufficient funds should also be allotted to furnish the laboratories with equipment, electricity, and chemicals and to conduct regular check-ups and maintenance of laboratories and apparatuses. Furthermore, the Ministry of Education should also establish clear and continuous communication with headmasters, headmistresses, and department heads concerning the lack of equipment in schools.

Textbooks

It is critical that the schools be supplied with modern quality textbooks for their libraries. The personnel of the Tanzanian Institute of Curriculum Development should work together with the subject teachers in secondary schools to develop books and other teaching and learning materials, such as guidebooks, workbooks, and booklets, to be used inside and outside of the classrooms. In addition, the higher education institutions should support and encourage faculty members to produce and publish subject books in various fields.

Overall, this study provided implications to the government and education development entities advocating for the advancement of secondary schools in Tanzania to reexamine their plans and decisions so as to meet the challenges presented in this study.

Implications for Future Study

The purpose of this study was to (a) understand how the professional development learning experiences of Tanzanian secondary school science teachers influence their instructional practices and (b) to examine the approaches that science teachers utilize in the classroom, specifically the inquiry-based approach. It is hoped that future studies can build upon these initial proceedings of research to inquire more deeply and widely into how the professional development learning experiences of science teachers influence their instructional development.

First, in determining whether the findings of this study are applicable to other government-funded secondary schools, it is recommended that future research replicate this study as to strengthen its findings. However, future research should involve a larger qualitative study, which covers more secondary schools in different cities across Tanzania. Second, it is also suggested that future research include participants who have had considerably sufficient experiences participating in professional development training to be selected as a sample for the study. Third, further studies should be conducted in private secondary schools to compare science teachers' professional development learning experiences and their influences on their instructional practices. Fourth, this study discovered that there were three groups who participated in professional development: the privileged, those with little experience, and those with no experience. Clearly, there was a discrepancy among teachers' access to professional development options. The recommendation for future study is that it should focus on the perceptions of administrators regarding the discrepancy of teachers' participation in the professional development programs. Future studies should investigate what criteria school administrators use in selecting science teachers to attend professional development activities.

Lastly, the Tanzanian educational context is decentralized, which entails a partnership in the distribution of responsibilities between the central government and the regions, the districts, and communities (Lillis, 1990). It is recommended that sustainable changes in the science curriculum can possibly be implemented mostly by the aforementioned administrators. Therefore, further relevant research initiated in this area could focus on the perceptions of administrators regarding modernizing the practical work in science subjects and how to rebuild feasible science curriculum for educational institutions in the country.

Implications for Practice

Tanzanian science teachers must be practical and plan their teaching within the actual constraints that limit their teaching and learning for students. They should work creatively and strive to surmount those existing limitations. Furthermore, teachers should help students develop scientific literacy and assist them in building a practical knowledge of science content so that they apply it to real-life situations. Lastly, when utilizing improvised tools in teaching science, teachers need to be accurate and precise; otherwise, there will be many errors in the practical activities, and this will create ineffective, useless, and unacceptable results (Owolabi & Oginni, 2012).

Strengths and Limitations of the Study

I believe my study will contribute to a large body of research regarding the importance of science teachers' professional development and how it influences their teaching practices. This study employed three qualitative methods of data collection which included "triangulation," a technique which assisted in providing information about the phenomena under investigation. Triangulation helped to enhance the validity of the claims made.

There were also some limitations which came up as a result of this study. First, the sample used in this study was too small to represent the whole population of Tanzania, because it only covered four schools. However, Tanzania has approximately 4,372 secondary schools (Barakabitze, 2014, p. 86). Considering this number, the current study serves as a small-scale study on the topic of the professional development of science teachers. Therefore, all major conclusions formulated in this study are basically applicable to the selected sampled schools, which include: Johari Secondary School (Dar es Salaam), Alonzo Secondary School (Dar es Salaam), Imani Secondary School (Arusha), and Olympia Secondary School (Moshi). Hopefully, the conclusions of this study will be valuable to educators, course developers, and the Ministry of Education and Vocational Training along with other stakeholders in Tanzania, because they can learn from the experiences of even a few science teachers from the aforementioned schools.

Second, this study focused only on the government-funded secondary school science teachers. Therefore, the professional development experiences of these teachers might be different from those of private schools. Third, participants reported their own experiences and perceptions regarding the professional development activities and the influence of those professional development opportunities on their practices. However, a majority of the participants had very little experience engaging in professional development activities, if any. Therefore, the findings of science teachers' experiences with professional development may, in one form or another, have been affected by this specific setting rather than science teacher education in its entirety.

Fourth, member checking was limited to only six teachers. Merriam (2009) and Birt et al. (2016) determined that member checking is a common approach for ensuring internal validity or credibility. Utilizing member checking for this study helped to increase the validity of the analysis by ensuring each teacher read the transcriptions of their interviews and field notes I collected to provide credibility. In the case whereby I was notified that the participants' narratives were not accurate, I received the opportunity to reflect on my biases and other sources of misinterpretation (Koelsch, 2013).

Fifth, I entered into the research context as an insider-outsider and benefited from it. As an insider, I had a superior understanding of the participants' culture; I interacted naturally with participants and everyone involved in the study; and therefore, I had a greater social (interpersonal) intimacy with the participants (Bonner & Tolhurst, 2002).

Summary

The description of science teaching in Tanzania was based on reports provided by science teachers. The triangulation of data from interviews, observations and a document review validated the results: It presented a breadth and depth to the analysis. This study discovered limitations that hampered the quality of science education. The findings revealed that there are numerous constraints, which led to the poor quality of science education offered in secondary schools in Tanzania. Although the findings of the study uncovered that science subjects were not taught effectively, there were limitations, however, mostly derived from the government policies which significantly influence the teaching of science subjects.

The deficits can be drawn from the poor delivery of and an imbalance in professional development activities, the lack of teaching resources, inadequacies in terms of laboratories and equipment, ineffective teaching methods for teaching science, the shortage of science teachers, the lack of laboratory assistants, large class sizes, the teachers' lack of motivation, the absence of the implementation of modern methods for science teaching, and the immense emphasis placed on completing the syllabus. The manner in which science subjects are presently taught in Tanzania results from the existence of these constraints.

The current status of science education calls for the following reformations: First, lessen the use of teacher-centered based teaching approaches by emphasizing inquiry-based science instruction. Second, develop and implement more effective professional development programs in the form of workshops and seminars, and ensure each individual teacher is given an equal opportunity to participate. Third, enact the provisions such as providing all kinds of resources and a good infrastructure so that the teacher can develop and implement successful practices in their classrooms. Fourth, put less emphasis on the completion of the syllabus to meet the requirements of the curriculum, and focus on teaching the subject matter so students will develop critical-thinking abilities and an understanding of science concepts. Fifth, develop science teachers’ motivation, especially utilizing such means as compensation, incentives, upgraded working conditions, and academic support. Improving these factors may boost their teaching fulfillment so that they can strive for excellence and successfully grow in their instructional practices. Enacting the above recommendations in consideration will enable science teachers to teach effectively and perhaps, increase students’ interests in science in secondary schools in Tanzania and beyond.

REFERENCES

Adil, M., & Neelam, F. (2013). Impact of rewards system on teacher's motivation: Evidence from the private schools of Karachi. *Journal of Education and Social Sciences, 1*(1), 1-19.

Anderson, R. (1996). *Study of curriculum reform. [Volume 1: findings and conclusions]*. Studies of Education Reform: Boulder.

Anderson, R. (2002). Reforming science teaching: What research says about inquiry? *Journal of Science Teacher Education, 13*(1), 1-12.

Anderson, S. (1997). Understanding teacher change: Revisiting the concerns based adoption model. *Curriculum Inquiry, 27*(3), 331-367.

Andrini, V. (2016). The Effectiveness of inquiry learning method to enhance students' learning outcome: A theoretical and empirical review. *Journal of Education and Practice, 7*(3), 38-42.

Aubusson, P., Ewing, R., & Hoban, G. (2009). *Action learning in schools: Reframing teachers' professional learning and development* (1st ed., pp. 1-160). New York, NY: Routledge.

Aulls, M., & Shore, B. (2008). *Inquiry in Education: The conceptual foundations for research as a curricular imperative* (Vol. 1). New York, NY: Lawrence Erlbaum Associates.

Banchi, H., & Bell, R. (2008). The many levels of inquiry. *Science and Children*, 46(2), 26-29.

Barakabitze, A. (2014). The Context of education initiatives, importance and inhibitors of ICTs towards improving teaching and learning in Tanzania: A critical literature review. *Information and Knowledge Management, 4*(10), 82-97.

Barrow, L. (2006). A brief history of inquiry: From Dewey to standards. *Journal of Science Teacher Education, 17*(3), 265–278.

Beavers, A. (2009). Teachers as learners: Implications of adult education for professional development. *Journal of College Teaching & Learning, 6*(7), 25-30.

Bell,R., Smetana, L., and Binns, I. (2005). Simplifying inquiry instruction. *The Science Teacher*, *72*(7), 30-33.

Berry, W. (2008). Surviving lecture: A pedagogical alternative. *College Teaching, 56*(3), 149-153.

Binns, I., & Popp, S. (2013). Learning to teach science through inquiry: Experiences of preservice teachers. *Electronic Journal of Science Education, 17*(1), 1-24.

Birt, L., Scott, S. E., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: a tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research, 26*(13), 1802-1811

Blatchford, P., Bassett, P., & Brown, P. (2011). Examining the effect of class size on classroom engagement and teacher-pupil interaction: Differences in relation to pupil prior attainment and primary vs. secondary schools. *Learning and Instruction, 21*(6), 715-730

Blatchford, P., Baines, E., Kutnick, P., & Martin, C. (2001). Classroom contexts: connections between class size and within class grouping. *British Journal of Educational Psychology, 71*(2), 283-302

Bogdan, R., & Biklen, S. (2003). *Qualitative Research for Education: An Introduction to Theories and Methods* (4th ed., pp. 1-291). New York, NY: Allyn & Bacon.

Bogdan, R., & Biklen, S. (2007). *Qualitative research for education: An introduction to theories and methods.* Boston, MA: Allyn & Bacon.

Bohrer, K., Ferrie, A., Johnson, D., & Miller, K. (2008). TA training workshops. *Association for Biology Laboratory Education (ABLE), 29*, 67-126.

Boeije, H. (2010). *Analysis in Qualitative Research*. Los Angeles, CA: Sage Publications.

Bonner, A., & Tolhurst, G. (2002). Insider-outsider perspectives of participant observation. *Nurse Researcher, 9*(4), 7-19.

Bonk C., & Cunningham, D. (1998). Searching for learning-centered, constructivist, and socio-cultural components of collaborative educational learning tools. In C. Bonk & K. King (Eds.), *Electronic Collaborators: Learner-centered Technologies for Literacy, Apprenticeship, and Discourse* (pp. 25-50). Mahwah, NJ: Erlbaum

Bransford, J., Brown, A., & Cocking, R. (1999). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press.

Bredeson, P., & Johansson, O. (2000). The school principal's role in teacher professional development. *Journal of In-service Education, 26*(2), 385–401

Brownell, M., Adams, A., Sindelar, P., Waldron, N., & Vanhover, S. (2006). Learning from collaboration: The role of teacher qualities. *Council for Exceptional Children, 72*(2), 169-185.

Bybee, R. (2000). Teaching science as inquiry. In Minstrell, J & Zee, E. (Eds.*), Inquiring into inquiry learning and teaching in science.* Washington, DC: American Association for the Advancement of Science.

Buysse, V., Sparkman, K., & Wesley, P. (2003). Communities of practice: Connecting what we know with what we do. *Council for Exceptional Children, 69*(3), 263-277.

Caffarella, R.S. (2002). Planning Programs for Adult Learners. San Francisco: Jossey-Bass

Cameron, R. (1997). Self-directed learning: Toward a comprehensive model. *Adult Education Quarterly, 48*(1), 18-33.

Campell, T., & Smith, E. (2013). Envisioning the Changes in Teaching Framed by the National Science Education Standards-Teaching Standards. *International Journal of Education in Mathematics, Science and Technology, 1*(3), 162-183.

Carson, D., Gilmore, A., Perry, C. & Gronhaug, K. (2001). *Qualitative Marketing Research*. London: Sage

Cercone, K. (2008). Characteristics of adult learners with implications for online learning design. *Association for the Advancement of Computing in Education Journal, 16*(2), 137-159.

Cervero, R., & Wilson, A. (1994). *Planning responsibly for adult education: A guide to negotiating power and interests*. San Francisco: Jossey-Bass.

Charmaz, K. (2006). Constructing grounded theory: A practical guide through qualitative analysis. Thousand Oaks, CA: Sage.

Cheung, D. (2007). Facilitating chemistry teachers to implement inquiry-based laboratory work. *International Journal of Science and Mathematics Education, 6*(1), 107-130

Chi, M. T. H. (2009). Active-constructive-interactive: A conceptual framework for differentiating learning activities. *Topics in Cognitive Science,* 1(1), 73-105.

Choi, S., and Ramsey, J. (2009). Constructing elementary teachers' beliefs, attitudes, and practical knowledge through an inquiry-based elementary science course. *School Science and Mathematics, 109*(6), 313–324

Corcoran, T. (1995). *Transforming professional development for teachers: A guide for state policymakers.* Washington, DC: National Governors' Association.

Corey, S. (1957). Introduction. In N. Henry (Ed.), in-service education. Fifty-sixth yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press.

Craft, A. (2000). *Continuing Professional Development*: A practical guide for teachers and schools, London: RoutledgeFalmer.

Craig, H., Kraft, R., Plessis, J. (1998). *Teacher development: making an impact*. Washington, DC: US Agency for Educational Development & World Bank.

Craig, R. (1996). *The ASTD Training and Development handbook.* New York: McGraw-Hill.

Creswell, J. (1998). *Qualitative inquiry and research design: Choosing among the five traditions.* Thousand Oaks, CA: Sage.

Creswell, J. (*2005). Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Thousand Oaks, CA: Sage.

Creswell, J. (2007). *Qualitative inquiry & research design: Choosing among five approaches* (2nd ed). Thousand Oaks, CA: SAGE Publications.

Creswell, J. (2009). *Research Design: Qualitative, quantitative, and mixed methods approaches* (3rd ed., pp. 1-296). Thousand Oaks, CA: SAGE Publications.

Cwikla, J. (2004). Show Me the Evidence: Mathematics Professional Development for Elementary Teachers. *Teaching Children Mathematics, 10*(6), 321-326.

Daly, A., Moolenaar, M., & Burke, B. (2010). Relationships in reform: The role of teachers' social networks. Journal of Educational Administration, 48(3), 359-391

Darling-Hammond, L., Holtzman, D., Gatlin, S., & Heilig, J. (2005). Does teacher preparation matter? Evidence about teacher certification, teach for America, and teacher effectiveness. *Education Policy Analysis Achieves, 13*(42).

Dass, P., & Yager, R. (2009). Professional Development of Science Teachers: History of Reform and Contributions of the STS-Based Iowa Chautauqua Program. *Science Education Review, 8*(3), 99-111.

Desimone, L. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181–199.

Desimone, L., Porter, A., Garet, M., Yoon, K., & Birman, B. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis, 24*(2), 81-112.

Dewey, J. (1902). *The child and the curriculum.* Chicago: University of Chicago Press.

Dewey, J. (1910). Science as subject-matter and as method. *Science*, *31*, 121–127

Dewey, J. (1916). Method in science teaching. *The Science Quarterly, 1,* 3–9.

DomNwachukwu, N., & DomNwachukwu, C. (2006). The Effectiveness of substituting locally available materials in teaching chemistry in Nigeria: A case for science education in developing countries. *School Science & Mathematics, 106*(7), 296-305.

Edelson, D., Gordin, D., & Pea, R. (1999). Addressing the challenges of inquiry-based learning through technology and curriculum design. *The Journal of the Learning Sciences, 8*(3/4), 391-450.

Egodawatte, G., McDougall, D., & Stoilescu, D. (2011). The effect of teacher collaboration in grade 9 Applied Mathematics. *Educational Research for Policy Practice*, *10*(3), 189-209.

Elliott, J. (2005). *Using narrative in social research: Qualitative and quantitative approaches*. London: (1st ed., pp. 1- 232). Sage Publications, Ltd

Engelbrecht, W., Ankiewicz, P., & Swardt, E. (2007). An industry-sponsored, school-focused model for continuing professional development of technology teachers. *South African Journal of Education, 27*, 579–595-579–595.

Finn, J. & Achilles, C. (1999). Tennessee's class size Study: Findings, implications, misconceptions. *Educational Evaluation and Policy Analysis*, *21*(2), 97-109.

Gall, D., Gall, J., & Borg, W. (2007). *Educational research: An introduction* (8th ed.). New York: Pearson Education.

Gallet, C. (1998). Problem-solving teaching in the chemistry laboratory: Leaving the cooks. *Journal of Chemical Education*, *75*(1) 72-77

Gibbs, G., & Coffey, M. (2004). The impact of training of university teachers on their teaching skills, their approach to teaching and the approach to learning of their students. *The Institute for Learning and Teaching in Higher Education and SAGE Publication,* 87–100-87–100. doi:10.1177/1469787404040463

Gibson, H., & Chase, C. (2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Wiley Periodicals, Inc.*, *89*, 693-705.

Glattenhorn, A. (1987). Cooperative professional development: Peer centered options for teacher growth. *Educational Leadership*, *45*(3), 31-35.

Glesne, C. (2011). *Becoming qualitative researchers: An Introduction*. Boston, MA: (4th ed., pp. 1 - 336). Pearson Education.

Gneezy, U., Leonard, K., & List, J. (2009). Gender differences in competition: Evidence from a matrilineal and patriarchal society. *Econometrica*, *77*(5), 1637–1664-1637–1664.

Greene, M. (2014). On the Inside Looking In: Methodological Insights and Challenges in Conducting Qualitative Insider Research. *The Qualitative Report*, *19*(15), 1-13.

Grossman, P. L., Wilson, S. M., & Shulman, L. S. (1989). *Teachers of substance: Subject matter knowledge for teaching*. In M. Reynolds (Ed.), the knowledge base for beginning teachers (p. 23-36). New York: Pergamon Press

Guba, E.,& Lincoln, Y. (1994). *Competing paradigms in qualitative research*. In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of qualitative research (pp. 105-117). Thousand Oaks, CA: Sage

Gulamhussein, A. (2013). Teaching the teachers effective professional development in an era of high stakes accountability. *Center for Public Education*.

Gunstone, R. F., & Champagne, A. B. (1990). *Promoting conceptual change in the laboratory*. In E. Hegarty-Hazel (Ed.), the student laboratory and the science curriculum (p. 159–182). London: Routledge

Guskey, T. (1986). Staff development and the process of teacher change. *Educational Researcher, 15*(5), 5-12.

Guskey, T. (1995). Professional development in education. In search of the optimal mix. In T. Guskey and M. Huberman (Eds.), professional development in education: new paradigms and practices (p. 114-131). New York: Teacher College Press.

Guskey, T. (1998). Making time to train your staff. *School Administrator, 55*(7), 1-3.

Guskey, T. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press, Inc.

Guskey, T. (2002). Professional development and teacher change. *Teachers and Teaching: Theory and practice, 8*(3/4), 381–391

Guskey, T. (2009). Closing the Knowledge Gap on Effective Professional Development. *Educational Horizons*, 224-233

Guskey, T. & Yoon, K. (2009). What works in professional development? *Phi Delta Kappan*, *90*(7), 495-500.

Hall, G., & Hord, S. (1987). Change in schools: Facilitating the process. Albany, NY: State University of New York Press.

Hall, G., & Hord, S. (2001). Implementing change: Patterns, principles, and potholes. Boston, MA: Allyn & Bacon.

Hall, G., & Hord, S. (2006). Implementing change: Patterns, principles, and potholes (2nd ed.). Boston, MA: Allyn & Bacon

Harris, C. & Rooks, D. (2010). Managing inquiry based science: Challenges in enacting complex science instruction in elementary and middle school classrooms. *Journal of Science Teacher Education*, *21*(2), 227-240

Hass, C. (1957). In-service education today. In N. Henry (Ed.), in-service education. Fifty-sixth yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press.

Hendricks, C. (2001). Teaching causal reasoning through cognitive apprenticeship: What are results from situated learning? *The Journal of Educational Research*, *94*(5), 302-310.

Hofstein, A., & Lunetta V. (2004). The laboratory in science education: foundation for the 21st century, *Science Education*, 88, 28-54

Holly, M., & Mcloughlin, C. (1989. Perspectives on teacher professional development. New York, NY: The Falmer Press.

Hook, S., Huziak-Clark, T., Nurnberger-Haag, J., & Ballone-Duran, L. (2009). Developing an understanding of inquiry by teachers and graduate student scientists through a collaborative professional development program. *Electronic Journal of Science Education*, *13*(2), 30-61.

Hsiung, P. (2008). Teaching reflexivity in qualitative interviewing. *Teaching Sociology*, *(36)*, 3, 211-226

Indradevi, R. (2010). Training for most capable workforce. *Advances in Management*, *3*(12), 49-54.

Johnson, C. (2006). Effective professional development and change in practice: Barriers teachers encounter and implications for reform. *School Science and Mathematics, 106*(3), 1-12.

Johnson-Bailey, J. (1999). The ties that bind and the shackles that separate: Race, gender, class, and color in a research process. *Qualitative Studies in Education, 12*(6), 659-670.

Kafyulilo, A., Rugambuka, I., & Moses, I. (2012). The implementation of competency based teaching approaches in Tanzania: The case of pre-service teachers at Morogoro teacher training college. *Universal Journal of Education and General Studies, 1*(11), 339-347.

Kafyulilo, A. (2013). Professional development through teacher collaboration: An approach to enhance teaching and learning in science and mathematics in Tanzania. *Africa Education Review, 10*(4), 671-688. doi:10.1080/18146627.2013.853560.

Kane, L. (2004). Educators, learners and active learning methodologies. *International Journal of Lifelong Education 23*(3), 275-286.

Karim, M., Huda, K., & Khan, R. (2012). Significance of training and post training evaluation for employee effectiveness: An empirical study on Sainsbury's supermarket ltd, UK. *International Journal of Business and Management, 7*(18), 141-148.

Kazempour, M. (2009). Impact of inquiry-based professional development on core conceptions and teaching practices: A case study. *Science Educator, 18*(2), 56-68.

Kazempour, M., & Amirshokoohi, A. (2014). Transitioning to inquiry-based teaching: Exploring science teachers' professional development experiences. *International Journal of Environmental & Science Education*, *9*, 285-309.

Kelchtermans, G. (2006). Teacher collaboration and collegiality as workplace conditions. A review. *ZEITSCHRIFT FUR PADAGOGIK, 52*(2), 220-237.

Keys, C., & Bryan, L. (2000). Co-constructing inquiry-based science with teachers: Essential research for lasting reform. *Journal of Research in Science Teaching*, *38*(6), 631-645.

Khan, A. (2012). Inquiry-based teaching in mathematics classroom in a lower secondary school of Karachi, Pakistan. *International Journal of Academic Research in Progressive Education and Development, 1*(2), 1-7.

Khine, M., & Fisher, D. (2003). Teacher-student interactions in science classrooms in Brunei. *Journal of Classroom Interaction*, *38*(2), 1-8.

Kibwika, P. (2006). *Learning to make change: Developing innovation competence for recreating the African university of the 21st Century* (pp. 1-207). Wageningen: Wageningen Academic.

Kihwele, J. (2014). Students' perception of science subjects and their attitude in Tanzanian secondary schools. *World Journal of Educational Research, 1*(1), 1-8.

King, N. (2013). Investigation of Factors Hindering Quality Education in Secondary Schools in Mbeya, Tanzania. *International Journal of Learning & Development, 3*(6), 52-63. doi:Doi:10.5296/ijld.v3i6.4843

Kiprop, J., & Verma, N. (2013). Teacher education and globalization: Implications and concerns in the 21st century. *Scholarly Research Journal for Interdisciplinary studies, 1*(5), 1-13.

Kitta, S., & Fussy, D. (2013). Bottlenecks in preparation of quality teachers in Tanzania. *Time Journals of Arts and Educational Research, 1*(5), 29-38.

Koelsch, L. (2013). Reconceptualizing the member check interview. *International Journal of Qualitative Methods, 12*(1), 168-179.

Komba, W., & Nkumbi, E. (2008). Teacher professional development in Tanzania: Perceptions and practices. *Journal of International Cooperation in Education, 11*(3), 67-83.

Knowles, M. (1980). *The modern practice of adult education: From pedagogy to andragogy. Revised and updated ed.* Englewood Cliffs, NJ: Cambridge, Adult Education.

Knowles, M., Holton III, E., & Swanson, R. (2005). *The Adult Learner: The definitive classic in adult education and human resource development* (6th ed.). Burlington, MA: Elsevier.

Kumpikaite, V. (2010) Human resource development in learning organization. *Journal of Business Economics and Management, 9(1),* 25-31.

Kvale, S. (1996). *Interviews: An introduction to qualitative research interviewing* (1st ed., pp. 1-344). Thousand Oaks, CA: SAGE Publications.

Lawrence, J., & Tar, U. (2013). The use of grounded theory technique as a practical tool for qualitative data collection and analysis. *Electronic Journal of Business Research Methods*, *11*(1), 29-40.

La Porte, A. (2015). Older adult responses to art curriculum and self-directed learning. *International Journal of Education through Art, 11*(1), 59–74-59–74. doi:10.1386/eta.11.1.59_1

Leach, J., & Scott, P. (2003). Individual and socio-cultural views of learning in science education. Science Education, 12 (1), 91–113.

Leonard, J., Boakes, N., & Moore, C. (2009). Conducting science inquiry in primary classrooms: case studies of two preservice teachers' inquiry-based practices. *Journal of Elementary Science Education*, *21*(1), 27-50.

Lieberman, A. (1995). Practices that support teacher development: Transforming conceptions of professional learning. Phi Delta Kappan, 76, 591-596.

Lieberman, A., & Mace, D. (2008). Teacher learning: the key to educational reform. *Journal of Teacher Education, 59*(3), 226-234.

Lillis, K. (1990). Management of decentralization of education in Tanzania: Towards the identification of training needs. *International Review of Education, 36*(4), 417-440.

Llewellyn, D. (2013). *Teaching high school science through inquiry and argumentation – second edition*. (2nd ed., pp. 1-258). Thousand Oaks, CA: SAGE.

Lodhi, A. (1994). Muslims in Eastern Africa - Their Past and Present. *Nordic Journal of African Studies, 3*(1), 88-98.

Lodico, M., Spaulding, D., & Voegtle, K. (2010). *Methods in educational research: From theory to practice.* San Francisco, CA: Jossey-Bass

Lotter, C., Rushton, G., Singer, J. (2013). Teacher enactment profiles: How can we help move all teachers toward inquiry practice through professional development? *Journal of Science Teacher Education*. *24* (8), 1263–1291.

Loucks-Horsley S., Love, N., Stiles, K. E., Mundry, S., & Hewson, P. W. (2003). *Designing professional development for teachers of science and mathematics* (2nd ed.). Thousand Oaks, CA: Corwin.

Loucks-Horsley, S., Stiles, K., Mundry, S., Love, N., & Hewson, P. (2010). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin Press.

Mabula, N. (2012). Promoting science subjects choices for secondary school students in Tanzania: Challenges and opportunities. *Academic Research International, 3*(3), 234-245.

Marshall, J., & Smart, J. (2013). Teachers' transformation to inquiry-based instructional practice. *Creative Education*, *4*(5), 132-142.

Maxwell, J. (2013). *Qualitative research design: An interactive approach*. (3rd ed., pp. 1-218). Los Angeles, CA: SAGE.

McBride, J., & Bhatti, M. (2004). Using an inquiry approach to teach science to secondary school science teachers. *Physics Education*, *39*(5), 434-439.

McLaughlin, M. (2001). Professional communities and the work of high school teaching. Chicago: University of Chicago Press.

McLaughlin, M. & Talbert, T. (2006). *Building school-based teacher learning communities.* New York, NY. Teacher College Press.

Meena, W. (2009). *Curriculum innovation in teacher education: Exploring conceptions among Tanzanian teacher educators*. Vasa, Finland: Abo Akademi University Press.

Merriam, S. (1988). *Case study research in education: A qualitative approach* (pp. 1-226). San Francisco, CA: Jossey-Bass.

Merriam, S. (1998). *Qualitative research and case study applications in education* (revised*).* San Francisco: Jossey-Bass.

Merriam, S. (2009). *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass.

Merriam, S. & Bierema, L (2014). *Adult learning: Linking theory and practice*. San Francisco: Jossey-Bass.

Merriam, S. & Simpson, E. (1995). *A guide to research for educators and trainers of adults* (2nd ed.). Malabar, FLA: Krieger

Merriam, S., & Tisdell, E. (2015). *Qualitative Research: A Guide to Design and Implementation* (4th ed., pp. 1-368). San Francisco, CA: Jossey-Bass.

Mercer, J. (2007). The Challenges of insider research in educational institutions: Wielding a double-edged sword and resolving delicate dilemmas. *Oxford Review of Education, 33*(1), 1- 17

Mertler, C. (2014). *Action Research: Improving schools and empowering educators* (4th ed., pp. 1-352). Thousand Oaks, CA: SAGE Publications.

Miles, B. & Huberman, M. (1994). Qualitative data analysis: *An expanded sourcebook* (2nd ed.). Sage Publications, CA: Newbury Park.

Miller, H., McNeal, K., & Herbert, B. (2010). Inquiry in the physical geology classroom: Supporting students' conceptual model development. *Journal of Geography in Higher Education, 34*(4), 595-615.

MoEC (1995). Education and training policy. Dar es Salaam: Tanzania.

MoEC. (2005). Curriculum for ordinary level secondary education. Dar es Salaam: Tanzania.

MoEVT. (2012). Report and Analysis of the Results. Dar es Salaam: Tanzania.

Moolenaar, N. Daly, A., & Sleegers, P. (2010). Occupying the principal position: Examining relationships between transformational leadership, social network position, and schools' innovative climate. Educational Administration Quarterly, 46(5), 623-670.

Msoka, V., Mtebe, J., Kissaka, M., & Kalinga, E. (2014). Developing and piloting interactive physics experiments for secondary schools in Tanzania. *Journal of Learning for Development*, *1*(3).

Mumba, F., Banda, A., Chabalengula, V., & Dolenc, N. (2015). Chemistry teachers' perceived benefits and challenges of inquiry-based instruction in inclusive chemistry classrooms. *Science Education International*, *26*(2), 180-194.

National Research Council. (1996). *National science education standards.* Washington, DC: National Academy Press.

National Research Council. (2000). *Inquiry and the national science education standards*. Washington, DC: National Academy Press.

Ndalichako, J., & Komba, A. (2014). Students' subject choice in secondary schools in Tanzania: A matter of students' ability and interests or forced circumstances? *Open Journal of Social Sciences*, (2), 49-56.

Nuangchalerm, P. (2009). Implementing professional experiences to prepare preservice science teachers. The Social Sciences, 4(4), 388-391

Nuangchalerm, P. (2011). In-service science teachers' pedagogical content knowledge. Studies in Sociology of Science, 2(2), 33-37.

Nuangchalerm, P. (2012). Enhancing pedagogical content knowledge in preservice science teachers. *Higher Education Studies, 2*(2), 66-71. doi:10.5539/hes.v2n2p66

Nyamba, S., & Mwajombe, K. (2012). Students' Preferences on Science Subjects: Does this Affect their Performance? A Case of Udzungwa Secondary School, Kilolo, Iringa, Tanzania. *International Journal of Science and Technology, 2*(8), 556-560.

Odagboyi, I., Sambo, M., Musa, A., & Onche, E. (2014). Innovations in teaching: Between research and classroom practice. *Journal of Education and Practice, 5*(1), 123-127

Odden, A., Archibald, S., Fermanich, M., & Gallagher, H. (2002). A cost framework for professional development. *Journal of Education Finance, 28* (1), 51-74.

Omebe, C. (2014). Human resource management in education: Issues and challenges. *British Journal of Education*, *2*(7), 26-31.

Omelicheva, M., & Avdeyeva, O. (2008). Teaching with lecture or debate? Testing the effectiveness of traditional versus active learning methods of instruction. *Political Science and Politics*, *7*(1), 603-607.

O-saki, M. K. (2007). Science and mathematics teacher preparation in Tanzania: Lessons from teacher improvement projects in Tanzania, 1965-2006. NUE 1 [Naruto University of Education] *Journal of International Educational Cooperation*, *2*, 51-64.

Owolabi, T., & Oginni, I. (2012). Improvization of science equipment in Nigerian schools. *Journal of Education and General Studies, 1*(3), 44-48.

Ozmon, H. & Carver, S. (2008). *Philosophical foundations of* education (8th ed.). Upper Saddle River, NJ: Pearson/Merrill Prentice Hall

Paulo, A., & Issa, T. (2013). Science teaching in developing countries: The contribution of outdoor activities approach on students' learning of biology in Tanzanian secondary school. *Journal of Education, 1*(1), 1-17.

Patton, M. (1990). Qualitative evaluation and research methods. (2nd ed.) Newbury Park, CA: Sage.

Patton, M. (2002). *Qualitative research & evaluation method* (3rd ed.). Thousand Oaks, CA: Sage.

Prah, M. (2013). *Insights into gender equity, equality and power relations in Sub-Saharan Africa* (pp. 1-398). Kampala: Fountain.

Preece, J. (2014). PhD study in South Africa as a community of practice: Benefits and challenges. *International Journal of Continuing Education and Lifelong Learning,6*(2), 41-58.

Quick, H., Holtzman, D. & Chaney, K. (2009). Professional development and instructional practice: Conceptions and evidence of effectiveness. *Journal of Education for Students Placed at Risk (JESPAR), 14*(1), 45-71.

Renyi, J. (1996). *Teachers take charge of their learning: Transforming professional development for student success.* Washington, DC: National Foundation for the Improvement of Education

Richey, H. (1957). Growth of the modern conception of in-service education. In N. Henry (Ed.), in-service education. Fifty-sixth yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press.

Ritchie, J., & Lewis, J. (2003). *Qualitative research practice: A guide for social science students and researchers*. (1st ed., pp. 1-352). Thousand Oaks: CA: SAGE Publications.

Roehrig, G., Michlin, M., Schmitt, L., MacNabb, C., & Dubinsky, J. (2012). Teaching neuroscience to science Teachers: Facilitating the translation of inquiry-based teaching instruction to the classroom. *CBE—Life Sciences Education, 11*(4), 413-424.

Rotherham, A., & Willingham, D. (2009). 21st century skills: The challenges ahead. *Educational Leadership 67*(1), 16–21.

Rweyongeza, D. (2012). Solving the puzzle of secondary education delivery in Tanzania. *CANTAN Policy Institute*, 1-16.

Saad, A., Mat, N., & Awadh, A. (2013). Review of theory of human resources development training (learning) participation. *WEI International Academic Conference Proceedings*, 85-93.

Saldana, J. (2009). *The coding manual for qualitative researchers*. Los Angeles, CA: SAGE.

Salifu, I. (2014). Barriers to teacher motivation for professional practice in the Ghana education service. *Policy Futures in Education,12*(5), 718-729.

Sandelowski, M. (1993). Rigor or rigor mortis: The problem of rigor in qualitative research revisited. *Advances in Nursing Science*, *16*(2), 1-8.

Saunders-Stewart, K., Gyles, P., & Shore, B. (2012). Student outcomes in inquiry instruction: A literature-derived inventory. *Journal of Advanced Academics*, *23*(1), 5-31.

Shulman, L.S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4-14

Semali, L., & Mehta, K. (2012). Science education in Tanzania: Challenges and policy responses. *International Journal of Educational Research*, *53*, 225-239.

Shah, S. (2004). The researcher/interviewer in intercultural context: A social intruder! *British Educational Research Journal*, *30*(4), 549-575.

Shuyler, A., & Vavrus, F. (2010). *Global competition and higher education in the United Republic of Tanzania*. In V. D. Rust, L. M. Portnoi, and S. S. Bagley (Eds.), Higher Education, Policy and the Global Competition Phenomenon. Palgrave Macmillan.

Schwab, J. (1960). Enquiry, the science teacher, and the educator. *The Science Teacher*, *27*, 6-11.

Schwab, J. (1962). The teaching of science as enquiry. In J. Schwab & P.F. Brandwein (Eds.), *the teaching of science* (1-103).Cambridge, MA: Harvard University Press.

Skinner, A. (2005). *Tanzania and Zanzibar* (2nd ed., pp. 1-432). London: Cadogan Guides.

Song, L., & Hill, J. (2007). A conceptual model for understanding self-directed learning in online environments. *Journal of Interactive Online Learning, 6*(1), 27-42.

Sottile, J. M., Carter, W., & Murphy, R. A. (2002). *The Influence of self-efficacy on school culture, science achievement and math achievement among inservice teachers*. Paper presented at the Annual meeting of the American Education Research Association, New Orleans, LA.

Stake, R. (1995). The art of case study research: Perspectives on practice. Thousand Oaks, CA: Sage.

Stigler, J. & Hiebert, J., (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom.* New York: The Free Press

Strauss, A. & Corbin, J., (1990). Basics of Qualitative Research. Newbury Park: Sage Publications.

Supovitz, J., & Turner, H. (2000). The effects of professional development on science teaching practices and classroom culture. *Journal of Research in Science Teaching, 37*(9), 963-980.

Swanson, R., & Holton, E. (2009). *Overview of training and development. Foundations of human resource development.* San Francisco, CA: Berrett-Koehler.

Taylor, J., & Bilbrey, J. (2012). Effectiveness of inquiry based and teacher directed instruction in an Alabama elementary school. *Journal of Instructional Pedagogies,8*, 1-17.

Thapar-Bjorkert, S., & Henry, M. (2004) Reassessing the research relationship: location, position and power in fieldwork accounts. *International Journal of Social Research Methodology, 7*(5), 363-381.

Thurlings, M., Evers, A., & Vermeulen, M. (2015). Toward a model of explaining teachers' innovative behavior: A literature review. *Review of Educational Research, 85*(3), 430-471.

Tillman, L. (2009). Comments on Howe: The never-ending education science debate: I'm ready to move on. *Educational Researcher, 38*(6), 428-440.

Tobin, K. (1990). Research on science laboratory activities; in pursuit of better questions and answers to improve learning, *School Science and Mathematics, 90*(5), 403-418.

Trna, J., Trnova, E., & Sibor, J. (2012). Implementation of inquiry-based science education in science teacher training. *Journal of Educational and Instructional Studies in the World, 2*(4), 199-209.

Trorey, G., & Cullingford, C. (2002). *Professional development and institutional needs* (1st ed.). Burlington, VT: Ashtage.

Tuckett, A. (2004). Qualitative research sampling-the very real complexities. *Nurse Researcher, 12*(1), 47-61.

UNESCO. (2009). Needs Assessment Study of Tanzania's Science Education. Retrieved from http:/ www.esrftz.org

Vavrus, F., & Bartlett, L. (2013). *Teaching in tension: International pedagogies, national policies, and teachers' practices in Tanzania*. Pittsburgh Studies in Comparative and International Education Series. Rotterdam: Sense Publishers.

Venkataram, P. (2008). An Article to clear up some misconceptions about the nature of research. *Indian Institute of Science,* 1-11.

Vygotsky, L. S. (1978). *Mind in society: the development of higher psychological processes*. Cambridge: Harvard University Press.

Wei, R., Darling-Hammond, L., & Adamson, F. (2010). Professional development in the United States: Trends and challenges. Dallas, TX: National Staff Development Council

Wenger, E. (1998). *Communities of practice: Learning and meaning in school*. New York, NY: Cambridge University Press.

Wertsch, J. (1985). *Vygotsky and the Social Formation of Mind*. Cambridge, MA: Harvard University Press.

Wertsch, J. V. (1998). *Mind as action*. New York, NY: Oxford University Press.

Wilen, W. (1990). *Teaching and learning through discussion*. Springfield, IL: Charles C. Thomas.

Wright, S., Horn, S., & Sanders, W. (1997). Teacher and classroom context effects on student achievement: Implications for teacher evaluation. *Journal of Personnel Evaluation in Education*, *11*, 57-67.

World Bank, 1999. Tanzania: Social Sector Review. Washington, DC.

Yin, R. (2003). *Case study research design and methods* (3rd ed.). Thousand Oaks, CA: Sage.

Yin, R. (2009). *Case study research: Design and methods (applied social research methods)*. (4th ed., Vol. 5, pp. 1- 240). Thousand Oaks, CA: Sage Publications.

Yin, R. (2011). *Qualitative Research from Start to Finish* (pp. 1-348). New York, NY: The Guilford Press.

Yin, R. (2014). *Case study research: Design and methods* (5th ed.). Thousand Oaks, CA: Sage Publications.

Vygotsky, L. (1962). Thought and language. Cambridge MA: MIT Press.

Vygotsky, L. S. (1978). *Mind in society: the development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Zimmerman, J. (2006). Why some teachers resist change and what principals can do about It. *NASSP Bulletin*, *90*(3), 238-249.

UNIVERSITY OF GEORGIA

THE EFFECT OF CONTINUING PROFESSIONAL EDUCATION ON SCIENCE TEACHERS' COMPETENCE AT SECONDARY SCHOOLS IN TANZANIA

Consent Form

(For Teacher Participants)

I, Susana Nkurlu, ask you to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being conducted and what it will involve. This form is designed to give you the information about the study so that you can decide whether participate in the study or not.

Please take the time to read the following information carefully. Please ask me (the researcher) if there is anything that is not clear or if you need more information. When all your questions have been answered, you can decide if you want to participate in the study or not. This process is called "informed consent." A copy of this form will be given to you.

You, ________________________________, agree to participate in a research study titled "The effect of continuing professional education on science teachers' competence at secondary schools in Tanzania" conducted by a doctoral student, Susana Nkurlu, phone number: [redacted] supervised by:

Dr. Laura Bierema
Department of Lifelong Education, Administration, and Policy
The University of Georgia
College of Education
850 College Station Road
405 River's Crossing
Athens, GA 30602
Email: bierema@uga.edu
Phone number: [redacted]

You do not have to participate in this study if you do not want to, and you can stop taking part at any time without giving reason(s) and without penalty. You can ask to have information related to you returned to you, removed or deleted from the research records, or destroyed.

Your involvement in the study is entirely voluntary, and you may choose not to participate or to stop at any time without penalty or loss of benefits to which you are entitled. If you decide to withdraw from the study, the information that can be identified as yours will be kept as part of the study and may continue to be analyzed, unless you make a written request to have the information removed, returned, or destroyed.

I have explained the following points to you:

The purpose of this study was to (a) understand how the professional development learning experiences of Tanzanian secondary school science teachers influence their instructional practices, and (b) examine the approaches that science teachers utilize in the classroom, specifically the inquiry-based approach.

If you volunteer to participate in this study, you will be asked to do the following:

1. Participate in an interview with the researcher that will take approximately 60 to 90 minutes. The interview will be scheduled at a time and place agreeable to both the researcher and yourself. During the interview, you will be asked to answer about 20 to25 open-ended questions. The interview will be audio-recorded. After the interview, the audio-recording will be converted into a written record that pseudonyms. If you request, you will be given a written copy of the interview.

Participation in this study requires agreeing to have your interview audio-recorded.

Please initial below if you agree to have this interview audio recorded.

_______I do not want to have this interview recorded.

_______I am willing to have this interview recorded.

There will not be photographs or video recording, but only voice recording.

2. You understand that your data will be used in conference presentations and publications. Your confidentiality will be protected.

3. Agree to allow the researcher to observe your classroom to learn the methods used when teaching science. Additionally, the researcher will have a dialogue with you for approximately 10-15 minutes afterwards to discuss with you some of your instructional processes.

There may be some benefit to you by agreeing to participate. As a participant, you will be given an opportunity to reflect orally on you teaching practices and professional development experiences and on what can best help you in your teaching progression. This reflection may bring about change and potential enhancements in your teaching abilities.

There may be some benefits to others as a result of your participation in the study. This study may contribute to enhancing student learning of science in secondary schools in Tanzania and the results of this study may be beneficial in recognizing factors that promote successful science teaching. This study may be significant to educators, especially those desiring to become inquiry-oriented teachers. In addition, the results of this study may serve to improve inquiry-based learning and teaching practice and enhance the relevant research.

No discomfort is anticipated during the interview.

With regard to risks associated with this study, there is a possibility that the participants and I will discuss issues that might affect their employment. However, I will keep all information confidential, and use it only for the purpose of my study. Please be assured that any information obtained about you as a participant in this study, including your identity, will be kept confidential. Your identity will be protected with pseudonyms, and all data, including audio-recordings, will be kept in a secured, limited access location by the researcher for 32 months. Then, audio-files will be destroyed in May of 2020. Your identity will not be revealed in any publication of the results of this study. Pseudonyms will be used in any write-up of the study.

The researcher, Susana Nkurlu will answer any further questions about the research, now or during the course of the project, and may be reached at: [redacted] or [redacted].

You as a participant will be offered the following incentives: 1 diary, 2 pens, 5 binder clips, and US$10.

Should you have any questions or concerns, you may contact me via my email address: skurlu@uga.edu. At this time, please ask any questions you may have now. If you have questions later, you may contact Dr. Laura Bierema at bierema@uga.edu or at [redacted]. If you have any questions or concerns regarding your rights as a research participant in this study, you may contact the Institutional Review Board (IRB) Chairperson at [redacted] or irb@uga.edu.

You understand the procedures described above. Your signature below indicates that you have read this entire consent form, and have had all of your questions answered to your satisfaction. You agree to participate in this study, and you will be given a copy of this consent form.

____________________	___________________	___________________
Name of Researcher	Signature	Date

Telephone: [redacted] (US) or +255[redacted] (Tanzania)
Email: snkurlu@uga.edu
Address: University of Georgia
145 Joseph E. Brown Hall
Athens, GA 30602

_______________________	_____________________	___________________
Name of Participant	Signature	Date

Please sign both copies, keep one and return one to the researcher

Additional questions or problems regarding your rights as a research participant should be addressed to the IRB chairperson in the Human Subjects Office at the University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411. Telephone: (706) 542-3199; E-Mail Address: IRB@uga.edu

TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY
(COSTECH)

Telephones: (255 - 022) 2775155 - 6, 2700745/6

Director General: (255 - 022) 2700750&2775315
Fax: (255 - 022) 2775313
Email: relearance@costech.or.tz

Ali Hassan Mwinyi Road
P.O. Box 4302

Dar es Salaam
Tanzania

RESEARCH PERMIT

No. 2016–306-NA-2016-155 **9th June 2016**

1. Name : **Susana J. Nkurlu**

2. Nationality : **Tanzanian**

3 Title : **"The Impact of Professional Development on Science Teachers Instructional Practices: A Case Study on the Inquiry based Science Method in Tanzania"**

4 Research shall be confined to the following region(s): **Dar es Salaam, Kilimanjaro, Arusha, Manyara**

5. Permit validity from: **8th June 2016** to **7th June 2017**

6. Contact/Collaborator: **Dr. Vivian Nkurlu, University of Iringa, Iringa**

7. Researcher is required to submit progress report on quarterly basis and submit all Publications made after research.

M. Mushi

for: **DIRECTOR GENERAL**

UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION SIENCE TECHNOLOGY AND VOCATION
[redacted] MUNICIPAL COUNCIL.

Ref: [redacted]

[redacted]

May 21th 2016

Susana Nkurlu
250 Epps Bridge Parkway, apt # 512
Athens, GA 30606

Dear Susana Nkurlu:

On behalf of [redacted] Secondary School, Tanzania, I am writing to formally display our awareness of the research you are planning to conduct at our school. We acknowledge that you anticipate to carry out your research by administering interviews to our science teachers and also conduct classroom observations.

As the school [redacted] I serve as an instructional leader of the school and I oversee the school operations. Therefore, I welcome and grant you, Susana Nkurlu permission to conduct your research. I understand you may recruit up to three science teachers as your participants and conduct interviews at our school over the next two months.

We are happy to participate in your study and contribute to this important research regarding science teaching in Tanzania.

If you have any questions or concerns, please do not hesitate to contact me at [redacted] [redacted]r via email at [redacted]

Sincerely,

[redacted]

DAR-ES-SALAAM

Susana J. Nkurlu
P.O. Box [redacted]
Dar es Salaam

July 5, 2016

Moshi Regional Commissioner
P.O. Box [redacted]
Moshi, Kilimanjaro

RE: PERMISSION TO CONDUCT RESEARCH IN DAR ES SALAAM, TANZANIA

Dear Honorable [redacted]

My name is Susana J. Nkurlu. I am a PhD Candidate at the University of Georgia, US. I am studying Adult Education, specializing in Human Resources and Organizational Development.

I have come to Tanzania for data collection. The title of my research is "The impact of professional development on science teachers' instructional practices: A case study on the inquiry-based science method in Tanzania".

I need to interview secondary school science teachers who teach Biology, Chemistry and Physics. The school where I plan to conduct interviews in Moshi is [redacted] Secondary School.

In order for me to start the interview process, I must inform and obtain permission from the Regional Commissioner as well as the Municipal Director. Therefore, I am hereby requesting permission to collect data from above mentioned secondary schools. Please help me in this matter so that my data collection will be successful.

I thank you so much for your support and consideration.

Sincerely,

Susana J. Nkurlu

Susana J. Nkurlu
P.O. Box [redacted]
Dar es Salaam

June 13, 2016

Dar es Salaam Regional Commissioner
P.O. Box [redacted]
Dar es Salaam

RE: PERMISSION TO CONDUCT RESEARCH IN DAR ES SALAAM, TANZANIA

Dear Honorable [redacted]

My name is Susana J. Nkurlu. I am a PhD Candidate at the University of Georgia, US. I am studying Adult Education, specializing in Resources and Organizational Development.

I have come to Tanzania for data collection. The title of my research is "The impact of professional development on science teachers' instructional practices: A case study on the inquiry-based science method in Tanzania".

I need to interview secondary school science teachers who teach Biology, Chemistry and Physics. The schools where I plan to conduct interviews in Dar es Salaam are [redacted] Secondary School, and [redacted] Secondary School.

In order for me to start the interview process, I must inform and obtain permission from the Regional Commissioner as well as the [redacted] Municipal Director. Therefore, I am hereby requesting permission to collect data from above mentioned secondary schools. Please help me in this matter so that my data collection will be successful.

I thank you so much for your support and consideration.

Sincerely,

Susana J. Nkurlu

Susana J. Nkurlu
P.O. Box [redacted]
Dar es Salaam

July 7, 2016

Regional Administrative Secretary
P.O. Box [redacted]
Arusha, Tanzania

RE: PERMISSION TO CONDUCT RESEARCH IN ARUSHA, TANZANIA

To Whom It May Concern:

My name is Susana J. Nkurlu. I am a PhD Candidate at the University of Georgia, US. I am studying Adult Education, specializing in Human Resources and Organizational Development.

I have come to Tanzania for data collection. The title of my research is "The impact of professional development on science teachers' instructional practices: A case study on the inquiry-based science method in Tanzania".

I need to interview secondary school science teachers who teach Biology, Chemistry and Physics. The school where I plan to conduct interviews in Arusha is [redacted] Secondary School.

In order for me to start the interview process, I must inform and obtain permission from the Regional Commissioner as well as the Municipal Director. Therefore, I am hereby requesting permission to collect data from above mentioned secondary schools. Please help me in this matter so that my data collection will be successful.

I thank you so much for your support and consideration.

Sincerely,

Susana J. Nkurlu

THE UNITED REPUBLIC OF TANZANIA
PRESIDENT'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

KILIMANJARO REGION:
Telegrams: 'REGCOM' KILIMANJARO
Tel. No. 027-2754236/7
Fax No. 027-2753248 & 027-2751381
E-Mail: ras@kilimanjaro.go.tz
In reply please quote:

REGIONAL COMMISSIONER'S OFFICE,
P.O. Box [redacted]
MOSHI.
TANZANIA.

Ref. No. FA.228/276/03"F"/[redacted]

5/07/2016

District Executive Director
[redacted] District Council
and Municipal Director
Moshi District Council.

Re: **RESEARCH PERMIT**

Refer to the above headlined subject.

I wish to introduce to you Susan. J. Nkurlu, who is bonafide Researcher of University of Georgia, USA

The title of research is: "THE IMPACT OF PROFESSIONAL DEVELOPMENT ON SCIENCE TEACHER'S" INSTRUCTIONAL PRACTICES: A CASE STUDY ON THE INQUIRY-BASED SCIENCE METHOD IN TANZANIA

Permission has been granted from July to OCTOBER 2016

Kindly give him/her required cooperation and make sure that he/she abides by all **regulations** and **directives.**

Thank you for your cooperation.

N.E. Mshana
for: **REGIONAL ADMINISTRATIVE SECRETARY**
KILIMANJARO

for, Regional Administrative Secretary
KILIMANJARO

Copy to:- Director General
TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY

: Susan J. Nkurlu

The United Republic of Tanzania
PRIME MINISTER'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

DAR ES SALAAM REGION

Phone Number: [redacted]
In reply please quote:

REGIONAL COMMISSIONER'S OFFICE,
P.O. Box [redacted]
DAR ES SALAAM

Date: 14/6/2016

Reg. No. [redacted]....

District Administrative Secretary,
[redacted]........................
DAR ES SALAAM

RE: RESEARCH PERMIT

Pro/Dr/Mr./Mrs/Ms/Miss. Susana Jackson Nkurlu is a student/researcher from The University of Georgia has been permitted to undertake a field work research on The Impact of Professional Development on Science Teachers Instruction Practice. A Case Study on The Inquiry-Based Science Method In Tanzania

From June 16 2016 to August 7 2016

I kindly request your assistance to enable him/her to complete his/her research.

....
For: Regional Administrative Secretary
DAR ES SALAAM

Copy to: Municipal Director,
[redacted]
DAR ES SALAAM

Principal/Vice Chancellor,
University of Georgia

THE UNITED REPUBLIC OF TANZANIA
PRIME MINISTER'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

ARUSHA REGION:
ADDRESS TEL. "REGCOM"
TEL: NO 254-5608/2502272/2502289
Fax Na. 254-5239/254-4386
E-Mail: rasarusha@pmoralg.go.tz
E-Mail:rasarusha@yahoo.com

REGIONAL COMMISSIONER'S OFFICE,
EDUCATION DEPARTMENT,
P.O. BOX 3032,
ARUSHA,

In Reply Please Quote:-
RC/AR/ED/[redacted]/VOL.11/[redacted]

20TH Julai, 2016

[redacted] Secondary
ARUSHA.

RE: INTRODUCTION TO MISS SUSANA J. NKURLU

Please refer to the above subject.

I would like to introduce to you Susana J. Nkurlu a Student at the University of Georgia USA. He wants to conduct a research titled **"The Impact of Professional Development on Science Teacher. A case Study of [redacted] Secondary"**. The research will be conducted Within three days From 21 July, 2016 to 24 July, 2016.

Kindly assist him the necessary cooperation.

Thank you for cooperation.

K. [redacted]
For:- REGIONAL EDUCATION OFFICER
ARUSHA

REGIONAL EDUCATION OFFICER
ARUSHA

C.C: Miss Susana J. Nkurlu- Student

BARUA ZOTE ZIPELEKWE KWA MKURUGENZI WA MANISPAA

SIMU NA [redacted]
FAX NO [redacted]

OFISI YA MKURUGENZI
UMTAA WA MISSION
S L P [redacted]
11883 - DAR ES SALAAM

Kumb. Na. [redacted]

17../..6./2016

Mkuu wa Idara
Idara ya ..Elimu Sekondary
HALMASHAURI YA MANISPAA YA [redacted]

YAH: KUMTAMBULISHA Susana Jackson Nkurlu

Husika na mada tajwa hapo juu.

Halmashauri ya manispaa ya [redacted] imemruhusu Mwanachuo toka ...The University of Georgia, USA Kufanya ~~'Project/Field~~/Research juu ya "The Impact of Professional Development on Science Teachers' Instructional Practices: A Case Study on the Inquiry-Based Science Method in Tanzania. Katika ofisi yako. 'Project/Field/Research' itaanza kuanzia tarehe 20./..6../2016 hadi ...5..../..8../2016.

Tafadhali mpe ushirikiano.

Nakutakia kazi njema.

Kny: MKURUGENZI
HALMASHAURI YA MANISPAA YA [redacted]

R. Muna
Kny: MKURUGENZI WA HALMASHAURI
MANISPAA YA [redacted]

The United Republic of Tanzania

Prime Ministers' Office

REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

[redacted]STRICT
Phone Address:
Phone No: [redacted]
In reply quote: Ref. No: [redacted]

DISTRICT COMMISSIONER'S OFFICE
[redacted] DISTRICT
P. O. Box 15486,
DAR ES SALAAM
Date: 14/6/2016

Municipal Director,
P. O. Box [redacted]
[redacted] – **D'SALAAM.**

RE: RESEARCH PERMIT

Prof./Dr./Mr./Mrs./Ms/Miss Susana Jackson Nkurlu, from The University of Georgia, she/he has been permitted to unde take a field work research on "The Impact of Professional Development on Science Teachers' Instructional Practices: A case Study on the Inquiry-Based Science Method in Tanzania" the case study at [redacted] District from 16/6/2016 to 7/8/2016.

Therefore, you are asked to give the said researchers necessary assistance and Cooperation.

[redacted]
District Administrative Secretary
[redacted]

Copy: Susana Jackson Nkurlu

Principal/Vice Chancellor,
University of Georgia

Kny: KATIBU TAWALA
(W) [redacted]

MOSHI MUNICIPAL COUNCIL

(All correspondence be addressed to the Municipal Director)

MUNICIPAL DIRECTOR: +255-027-2752344
ALL OFFICE: +255-027-2754371/4
FAX : +255-027- 2752906
E-MAIL: director.moshi@gmail.com
WEB SITE: www.moshimc.go.tz
blog-manispaayamoshi.com
TELEGRAPHIC ADDRESS: MANISPAA

MUNICIPAL HALL,
P.O. BOX [redacted]
MOSHI.

Ref. No. MMC/A.[redacted]/VOL.III/33

18/07/2016

Regional Administrative Secretary,
P. O. Box [redacted],
MOSHI.

RE: RESEARCH PERMIT

Please refer to your letter with Ref. No. FA.228/276/03"F"/33 dated on 5th July, 2016 regarding the above subject.

With this letter a permission has been granted to Ms. Susan J. Nkurlu a bonafide researcher from University of Georgia, U.S.A. to conduct a research with the title **"The Impact of Professional Development on Science Teachers" Instructional Practices : A case Study on the Inquiry – Based Science Method in Tanzania** with effect from July to October, 2016.

Best regards.

Mary T. Mbwambo
For: MUNICIPAL DIRECTOR
MOSHI

K.n.y MKURUGENZI WA MANISPAA
MOSHI

C.C: Head of Department,
Secondary Education,
MOSHI MUNICIPALITY - Please assist

: Ms. Susan J. Nkurlu - Please abide all regulations & directives

THE INTERVIEW PROTOCOL FOR SCIENCE TEACHERS

Received Professional Development

1. Does your school offer you any professional development opportunities to improve your teaching practices?
2. What kind of professional development opportunities are you provided with?
3. How often do you get to attend professional development activities inside and outside of your school?

Teaching Methods

1. Tell me about your science teaching history and experience. How did you become a science teacher? How long have you been teaching? What intrigued you about science?

2 How long have you been teaching at a secondary school? Which classes specifically do you teach?

3. How many students do you have in your class?
4. What are the main teaching strategies that you use in your classroom?
5. How many labs do you have in this school?
6. What possible teaching methods do science teachers use in general?
7. Do you use them?
8. Out of those, which one do you believe is best? Why do think that?
9. In your view, how do you think science should be taught?
10. How do students learn science effectively/best in your classroom? Please provide an example of a lesson that you taught and in which students certainly learned the presented concept.

Constructivist Method of Teaching and Learning (Inquiry-based approach)

1. What can you tell me about the participation of students in learning of science in our class?
2. What do you think a student-centered teaching approach is? Can you provide an example of a lesson with a particular topic? Which teaching materials would you need?
3. Are you familiar with an “Inquiry-based method”?
4. How would you define inquiry-based teaching to an individual who is unfamiliar with the method?
5. Have you used it before in your classroom? What do you perceive as the benefits and obstacles of inquiry-based teaching?
6. What challenges have you encountered in implementing inquiry-based teaching? What accomplishments have you experienced in implementing this method?

What are the ways you have implemented inquiry-based science in your classroom? Can you provide an example of an inquiry-based lesson that you taught your students before? How did the lesson turn out? How would you conduct the lesson differently in the future? How were students’ reactions to the inquiry-based lesson?

7. How do students participate in your class? What do you usually do to promote students’ participation in your class? If you notice students’ attitudes to be negative, what do you do to assist them?
8. In your opinion, what is the purpose of practical work or experiments in science learning? 9. In which topics are you able to conduct practical work and why is that so? In which topics are you not able to conduct practical work and why is that so?
10. Have you discussed with other teachers using the inquiry-based method in the science unit, informally or in meetings?

Observation Guide

1. What does the structure of the lessons look like (e.g., aspects of the lessons or the length of time for each lesson)?

2. How do teachers teach the lessons and what methods do they employ (e.g., lecturing, using a blackboard, or implementing inquiry)?

3. In what manner do teachers permit students to participate in the classroom activities (e.g., individually, in groups, or both)?

4. 4. How do teachers assess their classroom instructional practices? I will also view teachers' teaching portfolios and collect field notes during classroom observations. I will observe the interaction between the teacher and students and students with students.