**IMPROVING THE QUALITY OF SCIENCE EDUCATION IN TANZANIAN
JUNIOR SECONDARY SCHOOLS: THE STAKEHOLDERS' PERSPECTIVES,
ISSUES, AND PROMISING PRACTICES.**

By

JOHN FUNGULUPEMBE KALOLO

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ABSTRACT

Improving quality science education (SE) in many countries across the world has been a focus of international inquiry. Though Tanzania, like many other countries, has placed an increasing focus on improving the quality of SE experiences in its schools, little has been made to achieve this goal. This means the process of providing quality SE remains problematic and challenging. This study explores promising practices for improving the quality of SE in Tanzanian junior secondary schools (JSS) from the perspectives of 67 key SE stakeholders involving: educators, policy makers, parents, students, science alumni and selected education officers. In order to address the issue, the study used a mixed method approach involving interviews and questionnaires (with all respondents except students); document review, and focus group discussions (with students). A pragmatic perspective, with an emphasis on creating a more relevant, contextual, responsive and functional SE experiences in schools, was used as a lens. The study was conducted in two concurrent (embedded) phases within two regions in Tanzania beginning with in-depth interviews with policy makers and followed by intensive study of schools. All phases of data collection generated qualitative and quantitative data sets, which were then analysed using thematic analysis and descriptive statistics respectively. The findings of this research identified that despite policy articulation, the understanding and delivery of quality SE in Tanzanian JSS has remained debatable, divisive and antagonistic controversy over its meaning, value, nature, features and measures. As such, a comprehensive framework is needed to harmonise the existing and diverse conceptions of what quality SE is among different stakeholders. The findings also revealed that there are several contextual challenges rooted in the processes of planning, delivery, assessment and monitoring of quality SE practices in schools. Respondents identified these challenges as limiting the efforts to provide quality SE. Employing comprehensive and multiple frameworks to address the issue of quality SE is likely to help in making school SE experiences become as relevant, context responsive and functional as possible. This thesis hybridises an American pragmatism and uses it in linking and integrating collective and different perspectives towards identifying promising practices for quality SE in Tanzanian JSS.

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DEDICATION

This thesis is dedicated to my late father Zimbabwe Ally Kalolo; Peace Kalolo, Loveness Kalolo, Gladness Kalolo, Vanesa Kalolo (children); Mrs Witness Mlawwa John Kalolo (wife); Madam Theresa Wilson Ngando (mother) and to all educationists and researchers employing a pragmatic perspective to make science education relevant, useful, functional to the learners in Tanzanian JSS.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAAS	American Association for the Advancement of Science
ACSEE	Advanced Certificate of Secondary Education Examination
ADEM	Agency for Development Education Management Tanzania
A-Level	Advanced level of Secondary Education
BEST	Basic Educational Statistics of Tanzania
BEMP	Basic Education Master Plan
CFS	Child-Friendly Schools
CRC	Convention on the Rights of the Child
CSEE	Certificate of Secondary Education Examination
DED	District Education Directors
DEO	District Education Officer
ESDP	Education Sector Development Programme
EFA	Education for All
ESR	Education for Self-Reliance Policy
ETP	Education Training Policy
GMR	Global Monitoring Report
IAEEA	International Association for the Evaluation of Educational Achievement
ICBAE	Integrated Community Based Adult Education
ICASE	International Council of Associations for Science Education
ITEA	International Technology Education Association
JAST	Joint Assistance Strategy for Tanzania
JSS	Junior Secondary Schools
MEO	Municipal Educational Officer
MKUKUTA	Mpango wa Kupunguza na Kuondoa Umasikini Tanzania
MPAMITA	Mkakati wa Pamoja wa Misaada Tanzania
MoCD-GC	Ministry of Community Development, Gender and Children
MoEVT	Ministry of Education and Vocation Training
MoU	Memorandum of Understanding
NACTE	National Council for Technical Education and Vocational
NECTA	National Examination Council of Tanzania
NFE	Non-Formal Education
NGO	National Governmental Organisations
NRC	National Research Council

NSGRP	National Strategy for Growth and Reduction of Poverty
OECD-GSF	Organisation for Economic Co-operation and Development Global Science Forum
O-Level	Ordinary level of Secondary Education
COBET	Complementary Basic Education in Tanzanian
ODL	Open and Distant Learning
PMO-RALG	Prime Minister's Office, Regional Administration and Local Government Authority
PEDP	Primary Education Development Program
PEMP	Primary Education Master Plan
PISA	Programme for International Student Assessment
PSLE	National Primary School Leaving Examination
RAS	Regional administrative secretaries
REO	Regional Education Officer
RPCE	Report of the Presidential Commission on education
SEDP	Secondary Education Development Programme
SEIA	Regional Conference on Secondary Education in Africa
SEMP	Secondary Education Master Plan
SESS	Science Education Secondary Schools Project
SID	School Inspectorate Department
SSE	School Self-evaluation
STIP	Science Teacher Improvement Project
TEA	Tanzania Education Authorities
TIAE	Tanzania Institute of Adult Education
TEAMS	Teacher Education Assistance in Mathematics and Science
TIE	Tanzania Institute of Education
TCU	Commission for Universities
TLSB	Tanzania Library Services Board
TRC	Teacher Resource Centres
UNCRC	United Nations Convention about the Rights of the Child
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations International Children's Emergency Fund
UPE	Universal Primary Education
URT	United Republic of Tanzania
VETA	Vocational Education and Training Authority.

CHAPTER ONE

INTRODUCTION

1.0 Nature of the Study

The development of science education (SE) around the world has accelerated the pace of “science-driven change” in modern societies, allowing science as an educational subject to become more important than ever before (Lederman, 2008). In his article about “*Science Education and the Future of Humankind*” Lederman (2008) argues that:

We have arrived at a point in history where there must be a major increase in the capability of ordinary people to cope with the scientific and technological culture that is shaping their lives and the lives of their children (p. i).

With such an aspiration, improving SE has become of paramount importance in determining a country’s scientific status and its socio-economic power in today’s open economies. The desire to develop SE is clear and in many countries there is an opportunity to ensure that quality, relevant and sustainable SE is provided for every student (Hestenes, 2013). However, this desire has been thwarted by the loss of interest in science by many of today’s youth (Munro & Elsom, 2000; Malcolm, 1999). The fall in the number of secondary school leavers seeking careers in science, and the resulting situation where it is becoming difficult to find notable professionals in scientific fields, has become a matter of concern for most developing countries, including Tanzania. It appears that while the global demand for skills in a technology-based economy is increasing rapidly, little effort has been made towards improving SE in schools. In Tanzania, for example, secondary school SE, with the introduced “ward secondary schools” is facing a number of challenges related to the way science is enacted, which interferes with initiatives towards developing quality SE in schools (Hakielimu, 2007; Sumra & Rajani, 2006).

A review of the literature establishes that efforts to improve SE in most African secondary schools since the 1980’s have been impacted by a number of global challenges (Ogunmade, 2005; Ogunniyi, 1986) which have greatly influenced SE practices in schools. These challenges include: changes in science as a discipline itself, the evolution of societal needs, rapid changes in technology,

changes in scientific innovations, changes in the purposes of SE, the intensification of globalisation, changes in new theories of learning, changing labour force demands and the evolution of the market forces in science careers. These challenges have altered global educational needs and thereby challenged African schools' to transform their structures and processes of education towards more relevant issues for the learners and society at large (Fraser & Walberg, 1995; Levy & Murnane, 2005; Stewart, 2010; Wilmarth, 2010). Such challenges have also led to a mismatch between the knowledge and skills that the schools offer, and the competencies that school graduates need for them to face their futures confidently.

Tanzania as a developing country faces many of these same challenges, which have in turn increased the need to redefine SE practices; to make it more functional for learners and more effective in catering for their needs, especially the needs of those learners who choose to pursue the formal study of science beyond secondary education (Chonjo, Osaki, Possi, & Mrutu, 1996; Osaki, Hosea & Ottevanger, 2004). Another pressure on SE in Tanzania is the need to address the public outcry from parents and employers, including the private sector, who claim that there is a huge difference between the kind of graduates they expect and those being produced by schools, colleges and universities with science specialisations.

Investigating ways in which high quality and relevant SE can be best provided in Tanzanian secondary schools is necessary and pertinent because the issue has received limited examination in sub-Saharan African countries to date, and is consequently poorly understood in many of these countries (Ogunniyi, 1986; Organisation for Economic Co-operation and Development, 2006; Osaki, et al., 2004). This thesis explores ways to improve the quality of SE in Tanzanian Junior Secondary Schools (JSS). It considers the perspectives of international literature, key SE stakeholders such as educators, policy makers, parents, students, science alumni and selected education officers. In particular the study addresses the following four major research questions:

1. How is quality SE understood and articulated by the stakeholders?
2. What do stakeholders consider are desirable features for quality science education in Tanzanian junior Secondary Schools?

3. What are the challenges that most JSS have been encountering in providing quality SE?
4. What promising approaches or strategies can be used to address today's challenges for SE in Tanzanian JSS?

There have been a number of important reports related to SE in Tanzania over the past two decades, including those of Chonjo et al (1996) and Osaki et al (2004), that have strongly identified the need to improve SE in schools. Their contributions to Tanzanian science literature and their recommendations have made a major contribution towards better understanding the status of SE in the country. The aim of this study is to build on their work by establishing promising SE practices and frameworks for relevant, functional and sustainable quality JSS science education experiences among Tanzanian science learners; the areas that are missing in those reports.

By definition, the promising practices differ from other types of practices such as workable (best) practices in that; while the promising practices all pragmatic processes, programs and actions with strong quantitative and qualitative data showing positive outcomes, but do not yet have enough research evidence to support their effectiveness and their ability to produce desirable results, the workable practices (or best practices) involve all processes or programs that are proven by science experts as replicable in a variety of settings and able to produce desirable results (Harris & Gates, 2014; Spencer, Schooley, Anderson, Kochtitzky, DeGroff, Devlin, et al. 2013). Being pragmatic, the promising practices are still open to critique. Identifying the promising practices in Tanzanian JSS science education as anticipated by this study was regarded as being important in improving the school SE experiences, providing the direction to the better ways of enacting SE, and guiding the practice of SE towards developing learners who can play a more functional role in society (Diut & Treagust, 2003; Fensham, 2009; Goodrum, Hackling & Rennie, 2001).

This thesis uses concurrent (embedded) research design of mixed methods grounded in pragmatic perspectives. The pragmatic perspective is used as a theoretical lens for this study because of its strength in linking and integrating collective perspectives (different viewpoints) in this case the researcher's positionality, stakeholders' perspectives, experiences from national and

international literature and the evidence from empirical studies towards identifying promising practices for quality SE in Tanzanian secondary schools.

1.1 The Need for this Study

There are number of concerns related to SE in Tanzania that triggered the decision to undertake this study. These include:

- a) *The participation gap in SE.* There has been a persisting participation gap in SE among several disadvantaged groups (such as women, learners from rural areas, and learners from poor socio-economic status) in most African countries including Tanzania (Anamuah-Mensah, Mereku, & Asabere-Ameyaw, 2004; Martin, Mullis, Foy, & Stanco, 2012). These groups are seriously underrepresented in many science fields, a situation which limits their potential for participating in science studies and constrains their contribution to this field.
- b) *The lack of interest in science careers among many students.* This is demonstrated by the situation whereby many students have been turning away from science studies towards other professions; a trend which does not present a good promise for the future of Tanzania (Osaki, 2000a; 2007).
- c) *The poor schooling environment.* This includes the lack of competent teachers who are able to inspire their students, inappropriate professional development training among teachers as well as an absence of interesting and motivating curricular (Komba, & Nkumbi, 2008; Okeke, 2004). There is also a lack of clear shared standards for science and mathematics that would help all involved in the system to set and achieve goals (Reddy, 2006). As a result, too many students conclude early in their education that science subjects are too difficult, unfavourable, or boring, which leaves them inadequately prepared to face challenges in their futures (Mahlaba, 2006; Reddy, 2006b).
- d) *Lack of a science capable community.* Despite the fact that science is important, even for people who are not planning to become engineers, mathematicians or scientists (Holbrook, 2010; Ogunmade, 2005; Osborne & Dillon, 2008; Stronkhorst, 2001); Tanzania arguably lacks a

science capable community. An increasing number of jobs today draw on at least some knowledge or skill from science fields and every occupation has the potential to be transformed by scientific and technological advances. It can be argued that it is important for Tanzanian citizens to have an understanding of scientific and technological knowledge to prepare them to make informed decisions about issues facing their nation and the planet at large.

- e) *Lack of science-proficient workforce.* The nation's ability to solve problems and achieve economic growth seems to largely depend on cultivating a future workforce that is science literate (Okeke, 2004; Marion and Gonzales, 2013). This need is urgent in Tanzania because the country's economy needs a large and an increasing supply of workers who can use scientific knowledge and skills in their jobs to fuel scientific discoveries, innovations and entrepreneurship (OECD, 2007; Osaki, et al 2004).
- f) *Lack of future science experts.* Tanzania needs a steady stream of the best science researchers and innovators and a large pool of science experts with the knowledge and desire to advance science and technology in the country (Hamilton, Mahera, Mateng'e, & Machumu, 2010). Science experts can play an important role in providing knowledge that serves a nation in various socio-economic and cultural issues such as security, mining, communication and transportation. They can also help to develop the new ideas and inventions necessary for the country's technological development as well as inspiring and mentoring new generations of scientists, engineers, mathematicians and leaders in SE (Darling- Hammond, 2007; Marion & Gonzales, 2013). This group of professionals contribute immensely to economic growth, technological progress as well as developments in high-tech industries, medical research centres and engineering firms (Mullis, Martin, Minnich, Stanco, Arora, Centurino, & Castle, 2012). More importantly they also help in retaining these advantages by building a strong science expertise.

Looking at these concerns and considering how influential on contemporary Tanzanian SE they have been, it was important to conduct this study in

Tanzania, especially at a time when SE has become a common topic for the national media, public talks and policy debates. Through investigating the current state of SE in Tanzanian JSS, this study attempts to establish a knowledge base that would help to stimulate, facilitate and guide the reforms towards developing a high quality SE system for JSS in Tanzania.

1.2 Significance of the Study

The research findings presented in this thesis are expected to inform SE stakeholders about the practices that are most promising for producing relevant and quality SE in Tanzanian junior secondary schools. The study also intends to advance pragmatism as a research philosophy, and to illustrate its applicability as a pluralistic approach to improving SE practices in the Tanzanian context. The study also has the potential to initiate the application of pragmatic frameworks to address Tanzanian SE challenges; to stimulate a paradigm shift from the closed, non-flexible frameworks presently applied in Tanzania (Hakielimu, 2007; Hamilton, Mahera, Mateng'e & Machumu, 2010; Komba, 2006; Mrutu, Ponera & Nkumbi, 2005; Sumra & Rajani, 2006) to the more open, flexible and pluralistic approaches that will be useful in establishing functional, authentic and context-responsive SE practices.

This study will also examine, critique and consider SE as it is practiced in a number of other countries. This process will acknowledge the cultural and contextual differences that exist in these countries, and will be cognisant of the limitations that many practices may have when transferred to the Tanzanian context. While acknowledging that there have been a variety of approaches in previous studies describing the best ways to enact SE in Tanzania, this study is not about establishing a new philosophical foundation, but rather about bringing together all lines of inquiry through pragmatism for the sake of providing harmonised promising suggestions aimed at improving the quality of SE in Tanzanian secondary schools. The findings of the study may also contribute to the definition of a systematic and sustainable framework for quality SE in Tanzanian JSS, which could in turn guide debate and reforms.

1.3 Structure of the Thesis

This section provides an outline of the study.

Chapter 1 presents the nature and purpose of the study presented in this thesis. It discusses the current SE system in Tanzanian JSS, while identifying the gaps that have led to the development of this study. The chapter concludes by identifying the significance and the structure of the thesis.

Chapter 2 provides the theoretical framework with which this study was undertaken, the pragmatic stance, which shapes this research project, and the recommendations presented. Chapter 2 also discusses why pragmatism is the most suitable theoretical stance for the context and data examined.

Chapter 3 contextualises the research focus by introducing Tanzania and its education system, and discusses the general situation of education in Tanzania.

Chapter 4 highlights discourses around quality SE internationally and nationally, with the attention paid to the particular context of Tanzania. The chapter also outlines how issues about SE which are debated internationally and mirrored in current SE practices Tanzanian JSS.

Chapter 5 discusses the colonial legacy and its influence on current SE practices in Tanzania. The chapter starts by identifying the dominance of western science over context responsive SE in Tanzania, and goes on to posit the grounds for questioning the dominance of western science educational practices in Tanzanian science classrooms.

Chapter 6 is about the research approach that underlines this study and presents the methodology that addresses the research questions. The chapter also describes the research design, justifying the methodology and explaining the methods of data collection and data analysis. The chapter also addresses research credibility, trustworthiness and ethical issues.

Chapter 7 analyses of the results and findings from the in-depth semi-structured interviews conducted with a sample of each stakeholder group are presented in this chapter. It outlines stakeholders' conceptions about quality science education (SE) and its desirable features.

Chapter 8 presents the findings in relation to various limiting factors, especially regarding quality SE as articulated by the stakeholders. Attention is paid to strategies stakeholders suggest in overcoming the stated limiting factors. Data

from all sources such as interviews, questionnaires and focus group discussions are triangulated to address the phenomena at hand.

Chapter 9 presents the discussion of the controversies that emerged from respondents' regarding quality SE. This chapter provides the implications of these controversies in understanding quality SE, as well as identifying dilemmas and providing new commitments that stakeholders need to undertake to achieve high standards in JSS science education.

Chapter 10 discusses the barriers and challenges towards providing quality SE in Tanzanian JSS. The chapter closes with drawing the implications of the continued prevalence of such challenges towards providing quality SE in Tanzania.

Chapter 11 discusses some promising practices suggested by respondents in the light of the present challenges in Tanzanian JSS science education. The chapter summarises how different SE challenges have developed to become problems and discusses various approaches to solving them.

Chapter 12 Concludes with a summary, major findings and the contribution of the thesis to the SE literature. The study also looks at research limitations that may be addressed in future work and also offers some specific recommendations and scope for further research.

1.4 Summary

This chapter introduced the nature of this study by highlighting the need for this study in Tanzania. The four major research tasks that shall be reflected throughout this thesis are presented in this chapter. Further, the research questions and the significance of this study are also presented in this chapter.

CHAPTER TWO

PRAGMATISM AS A THEORETICAL STANCE FOR THE STUDY

2.0 Introduction

The dysfunctionality and irrelevance of Tanzanian SE has become a source of concern for many Tanzanians, including educationists, educational partners, and the public at large. It has been evident, for example, that the public has been lamenting that the contemporary Tanzanian SE system has failed to address a number of basic issues in Tanzania (Osaki, 2004; Sumra & Rajani, 2006). These issues include unemployment, illiteracy, poverty, disease, communication, famine and superstition. Arguably, these failures have increasingly affected the nation's capacity to progress economically.

It is surprising that even in the twenty-first century, an era internationally dominated by science and technology, the Tanzanian SE system has contributed little to the nation's development (Osaki, 2007). This suggests that Tanzanian SE is divorced from the expectations of Tanzanian society, a situation which makes SE irrelevant and non-functional to Tanzanian lives. The existence of this problem has also increased the need for solutions to bring SE closer to Tanzanian lives; an initiative which is possible through the pragmatic perspective. This study employs a pragmatic approach to examine the stakeholders' perspectives towards current SE, to identify issues influencing SE and to identify promising practices for quality SE in Tanzanian JSS.

2.1 Conceptualising the Concept of Pragmatism

The term pragmatism is derived from the Greek word "*pragma*" (meaning "deed, work or act"), which is a derivative from the word "*prassō*", meaning "to pass over, to practice, and/or to achieve" (Rosenthal & Thayer, 2011; Singh, 2007). The etymological meaning identifies pragmatism as a practical (action-oriented) approach to finding solutions for existing problems and issues. Pragmatism signifies practicality, compromise, prudence and a clear goal orientation in dealing with problems. Throughout the literature, pragmatism is identified as an American philosophical movement founded by C. S. Peirce, John Dewey, and William James (Peirce, 1992).

Pragmatism has been considered to be a useful lens that can help in understanding debates and discourses in complex situations (Dewey, 1956; Trohler & Oelker, 2005). According to Arif, Smiley and Kulonda, (2005) pragmatism is also related to instrumentalism as propounded by John Dewey and it is related to real-world applications of knowledge and skills attained by learners as a product of schooling (Dewey, 1897; 1973). Pragmatism is also based on progressivism where value is placed on knowledge that is useful for survival (Reed & Johnson, 2000).

The central doctrine of pragmatism is the view that the value of ideas is based on their practical bearing and the functions they have in guiding actions (Pratt, 2002; Rescher, 2000; Robert, 2000). Classical pragmatists, such as Peirce, James and Dewey, opposed the theory of truth and knowledge as representation. In their view knowledge and the acquisition of knowledge should be focused within the concept of action, work and consequences to people's lives (Rorty, 2004; Biesta & Burbules, 2003). These pragmatists were against falling into the solipsism, subjectivity and relativistic concepts of truth by the notion of dogmatic definition and understanding about the concepts.

Hence, the most common interpretation of the term pragmatism is applying what works best, making it a philosophy or theory of 'workability' (Enoh 1995; Delputte, 2013). To the pragmatists what is true is what works best in enabling one to overcome an immediate problem (Okoh, 2003). They also view knowledge in terms of its ability to work and provide satisfactory impacts. With the world constantly changing, what works today may not necessarily work in the future, therefore because of the constant changes in global knowledge, there is no absolute truth in pragmatism.

Pragmatism is also an outgrowth of British Empiricism, which is based on both transformational and instrumentalist philosophy in education (Sleeper, 2001). Pragmatism as used in this thesis means doing what is realistic in light of existing constraints. Roskelly and Kate (1998) conventionally posit that the pragmatist looks for the most efficient means to an end, without stopping to question the authenticity of the practices at hand, because focusing on those details would reduce the efficiency and practicality of the practice. Pragmatism as viewed today is a holistic philosophy that works to manage the world and

human experience in ways that produce the best connections to daily actions, requiring real examples and to real-life experiences (Creswell, 2003; Fontrodona, 2002; Rescher, 2000; Rorty, 2004). James (1907) argued that pragmatism focuses on making “a positive connection with the actual world of finite human lives” (p. 20). It also looks towards “concreteness and adequacy, towards facts, towards action and towards power” (James, 1907 p.51).

The classical pragmatists, such as Charles Sanders Peirce, John Dewey and William James, put forward the foundations under which truth, knowledge, wisdom, ideas and thoughts can be defined (Stumpf & Fieser, 2008). On the other hand Rorty (2004) warns about the disconnectedness of most actions (educational practices in this case) to life experiences and objective truth. The central message presented is that there is little value in philosophical educational theories that do not somehow make a difference in people’s daily lives.

The current drive by contemporary pragmatists towards solving the challenges in education is based on the fact that rather than striving to attain absolutes or certainty in our practices, efforts should be made to come up with something that works and makes sense of the present life experiences (Gideon, 2003; Pratt, 2002; Robert, 2000; Rorty, 2004). In so doing, these contemporary pragmatists also provide the foundation for developing ideas that work best in specific educational systems (Haack, 2006).

2.2 Forms of Pragmatism

The literature identifies pragmatism as occurring in a number of different forms including: Experimentalism, humanistic, biological, consequentialism, optimism, and pluralism. In the context of this thesis, all forms of pragmatism were echoed except of experimentalism which demands testing the findings through experiments. Table 1 presents the different forms of pragmatism, their central emphases and beliefs.

Table 1: Forms of Pragmatism

Dimension	Focus about knowledge	Beliefs
Humanistic	Satisfaction of the needs, requirements, aspirations and objectives of human beings and caters to the welfare of mankind	-Problems as the motives of truth -Social and democratic values -Importance of man power
Experimentalism	Verifiable knowledge through experiments	-Activity and consequence based
Biological	Enables the individual to adjust with the environment and to change it to suit his needs and requirements.	-Changing nature of truth
Consequentialism	Some utility functions to mankind in a certain set of times i.e. such knowledge has positive consequences or results.	-Truth is formed by its results
Progressivism	-New values for an unknown future, a better, happier and richer life.	-Opposes fixed social customs and traditions, absolute values and ideas
Optimism	Dynamic, flexible and adaptable knowledge that can help in creating new values for an unknown future	-Faith in the present and future -Practical coping with the problems in the context of the day-to-day realities
Pluralism	Diverse view about knowledge and the promising ideas.	-Pluralism, flexibility and an opposition to the old doctrines of idealism and naturalism

2.3 Basic Tenets of Pragmatism

Unlike liberal foundationalism, critical philosophers and/or contemporary political philosophers, pragmatists are not conservative philosophers, but rather they support liberal principles of meliorism, which emphasise the necessity of reforming existing practices and discarding processes that have failed to achieve their intended purposes (Roskelly & Kate, 1998). In pragmatism there is always room for critical re-examination of best practices (Dewey, 1903). The function of pragmatism is not to critique, but to help in a promising course of action within a context where those involved (SE stakeholders in this particular case) are not neutral to the process but directly engaged in the discussion (Delputte, 2013; Marsh & Willis, 2003). Unlike other philosophical views pragmatism does not involve a collection of arguments or points of view; rather each argument is assessed for its contribution to on-going practices (Anderson, 1990). The pragmatic perspective therefore is more suitable for critical analysis

of issues within a society than many other worldviews, including those laid out by critical studies.

In contrast to logical positivism, which incorporates only epistemology and logic, pragmatism as applied today includes all five branches of philosophy (metaphysics, epistemology, logic, ethics and aesthetics) in articulating the whole of a particular phenomenon (Rescher, 2000). It is also distinct from realism, which celebrates the idea, that we live in order to learn. Pragmatism, by contrast, insists on “learning in order to live” (Ardalan, 2008, p. 22).

In relation to other more positivist philosophical orientations where arguments are accustomed and absolutist in nature, pragmatism contains a realistic reflection whereby the validity, relevance and usefulness of the arguments are the issues of central concern. In general, pragmatism assumes itself into a non-aligned position where multiple views about knowledge are favoured. For this reason, pragmatism is preferred as an approach for creating harmony among opposing philosophical standpoints (Rosamond, 2007).

2.4 Pragmatism and Education

Pragmatists believe that education must be conceived as a continuing reconstruction of experience. Dewey (1903) relates such experiential reconstruction as a process through which traditional practices in education are revised in light of what has been learned about their consequences. He also considers a need for curriculum to be designed so as to eliminate the gap that exists between what is learnt in school and public needs and preferences. Dewey, and all other pragmatists, asserts that genuine knowledge emanates from the problems or difficulties that exist in society. This implies that an adequate curriculum must be activity centred and provide opportunities for the learners to explore and solve problems themselves. Similar to humanists, pragmatism recommends learning by doing, and teaching being based on students’ interest and experience (Mishra, 2000; Maples, 1979; Khatib, Sarem, & Hamidi, 2013).

The pragmatists see the role of the school as linking new experiences in school to those of the wider society. This notion is cemented by Dewey (1897) who argues that education is “a process of living and not a preparation for future living” (p. 78-80). The goal of learning for pragmatists is therefore to create

constantly new competences to fit the contemporary situation so that instead of reproducing current habits, better habits are formed and thus the future adult society is improved (Dewey, 1897).

Singh (2007) claims that pragmatism does not believe in fixed aims of education, because human needs always change with changing times, places and circumstances. It is noted by this author that no specific aims of education can hold true and be applicable for all children at all times, places and situations. It is therefore necessary to have educational aims that enable the learner to continuously grow and create new values, which provide him/her with dynamic direction and guidance towards intrinsic interest, strong attitude and capacities in their areas of specialisation.

With a pragmatic perspective, the attributes of teachers are vital, in that it is not sufficient for teachers to know their subject matter (Hashweh, 2013; Harris & Jenz, 2006). They must also be able to focus on the growth of individual students, towards developing problem-solving skills, and be able to teach in open situations. Seltzer- Chung and Walsh (2000) and Kelly (2008) insist that a good teacher is the one who pays close attention to the particularities of individual students and their environmental influences so that every instructional strategy can be adjusted in light of these. Dewey looks at the teacher's job as a constant interactive intervention to contemporary problems with and by the students and to cultivate students with a caring but firm hand, like that of a gardener (Seltzer-Kelly, 2008). This contention is supported by McClellan and Dewey (1908) who insist that a teacher must master a large number of different methods to support learning, and be able to vary them according to situational needs. The authors further consider that "only knowledge of the principles upon which all methods are based can free the teacher from dependence upon the educational nostrums which are recommended like patent medicines, as panaceas for all educational ills" (p. 10). Anderson (2002) and Hardman (2014) relate this view to the process of making the teacher less important than the learner in the learning process because it is toward the learner that many types of learning are centred.

In a pragmatic approach the student is usually placed in a situation where he/she can personally experience the problems and consequently be able to

impose a meaningful framework on the unruliness of the case facts, search for the key pieces of data, distinguish central facts from peripheral ones, organise the conflicting explanations and alternatives presented to them and arrive at a reasonable recommendation for action (Ardalan, 2008). In this way learners are given a chance to express their views, feelings, reactions, attitudes and prejudices, which are reinforced or rejected by their colleagues, as well as providing an opportunity to re-evaluate and re-appraise their progress in learning (Education Review Office (ERO) (2005).

2.5 Relevance of Pragmatism to this Study

As applied in this thesis, pragmatism is viewed as a line of inquiry that helps in shifting conceptions about knowledge from fixed, faulty and rigid standpoints (in this case fixed SE orientations and practices that have been commented since independence) to more diverse ways of looking at relevant and quality SE. It is also considered helpful in finding out how philosophical conceptions, assumed as beliefs, can influence a school's practices, thus providing an opportunity to investigate the bearings of these conceptions in practice (Marcella, Kyalo, Kadenyi, & Kegode, 2009; Taatila & Raij, 2012). With its ability to stretch the dogmas and universally unchanging practices in education, pragmatism is helpful in modifying and updating non-working practices by setting each one to work (James, 1907). In relation to the present study, pragmatism is relevant in a number ways, as described in the subsections that follow.

2.5.1 Pluralistic View in Addressing Issues in SE

Pragmatism embraces the notion of plural and dynamic realities (multiple truths) and not only rejects the narrow confines and structures of absolutism but also offers an approach grounded in the emerging conversation that supports a diversity of viewpoints about the phenomena, quality SE in this particular case (Creswell, 2003; Rorty, 2004; Rosamond 2007). Unlike other worldviews, pragmatism is not informed by formal theory, but by accumulated practices, practitioner and administrator knowledge, the findings from previous research and the views expressed by the public (Biesta & Burbules, 2003). It is argued in this study that pragmatism offers a more diverse and interpretive approach that would help to solve problems related to the quality of SE in Tanzanian secondary schools as it refutes the Aristotelian methods (belief in given reality)

which have been celebrated and embraced in Tanzanian education practice since independence.

2.5.2 Emphasis on What Works Best in Solving Societal Educational Issues

Pragmatism emphasises what works best, that is, finding a measure of goodness that works rather than what may be 'inherently' true (Goodman, 2005; Rosenthal, & Thayer, 2011). Pragmatism is well known for its emphasis on utility of all educational practices in that only those subjects, activities and experiences that are useful to the present needs of the learner and that meet the future expectations of adult life are included in the curriculum (Fensham & Rennie, 2013; Petrou, 2007). In this study pragmatism is viewed as the world view that provides an avenue to test the utility of the educational outcomes. Utility in this thesis is related to the fulfilment of learners' needs. The assumption that this thesis holds is that utility in the education process should be the first criterion for judging whether schools are providing quality SE experiences that are relevant and useful (MOEC, 1999).

2.5.3 Emphasis on the Changing Aims of Education

Pragmatists do not believe in any pre-conceived, final, fixed and immutable aims of education as advocated by positivistic theorising (Morgan, 2007; Johnson & Onwuegbuzie, 2004; Patton, 2002). The belief celebrated by pragmatists is that the aims of education out of on-going experiences should lie wholly within the learner's experiences. With a changing world full of uncertainty and a shifting future, educational experiences are prone to change (Creswell, 2009). In such a dynamic environment there is a need to reshape the existing aims of education to meet new social needs and this is possible through pragmatism. In a country such as Tanzania, the positivist theorising inherited from colonialism has likely contributed in limiting the SE policymakers and researchers from pragmatically engaging with those issues that are not easily measurable.

2.5.4 Assertion of Learning by Doing as the Key to Learning

Pragmatists believe that knowledge results through interactions (action or doing) in which the individuals interacting experience the consequences of their actions and they can use this knowledge to solve subsequent problems (Levin

& Greenwood, 2011). Therefore, for one to acquire the necessary knowledge to solve problems, interaction is a necessary component (Dewey, 1944). In Enoh's (1995) book, Dewey states that "there is no such thing as genuine knowledge and fruitful understanding except as the offspring of doing" (p.109). By implication, this means that learning by doing is important for developing a strong knowledgebase among learners. In contradiction with Dewey's view, however, practical science in Tanzanian JSS is devalued, and most of JSS are conducting the so-called "alternative to practical" (learning by theory) (Mafumiko, 2004).

2.5.5 Contention of Education as Life-Long Learning

As a solution to the constantly changing world, knowledge needs to be updated in order to best address evolving issues. In this case, pragmatists recommend the type of education that continues until adulthood (Dewey, 1944), that is, life-long education as described by Nzeneri (2010). A fault currently identified in the formal JSS education system in Tanzania is that SE is regarded as a separate entity which lacks connection with other forms of education, including non-formal and informal activities (Wedgwood, 2007). This situation presents the need to redefine the philosophy of education in terms of its ideological commitments so that the formal education system is as meaningful, relevant and functional to society as possible (Middlecamp, 2008). Pragmatism qualifies as a relevant approach towards quality and relevance, especially where the education is considered to be the constant reconstruction or reorganisation of experiences to meet the challenges of later problems (Dewey, 1944).

2.5.6 Linking of Educational Practices to the Learners' Needs, Interests and Experiences.

Pragmatists believe that a quality education is not only one that is able to link new experiences in school to those required in the society, but is one that is derived from human needs and desires (Dewey, 1944). Pragmatists insist on educational practices being related to pupils' interests and experiences, and consider this a central aim for education. Pragmatism favours a diverse curriculum in order to take care of differences between learners, and also to centre the needs of learners as owners of their learning.

Exposing every individual learner to the same curriculum as is happening in today's JSS is to ignore important diversity of learners (Windschitl, 2009). This is one reason this study places pragmatism as a relevant theoretical lens for examining the connection between education outcomes and overall community needs. Another reason is that pragmatism may also help in providing solutions to the present predicament of poor quality SE in Tanzanian JSS, especially in closing the gap between what is learnt in school and what learners and their community need from education.

2.5.7 Promotion of Democratic Based Learning

Pragmatists are attracted by the idea of democracy because in a democratic community there is give and take; free interaction exists between individuals and social groups, and there is an exercise of human freedom, character, intelligence and other potentialities (Enoh, 1995). This study argues that in a situation where the teacher's authority obliges the learner to accept whatever comes from them, it is necessary for educational practices to be made democratic; where both teachers and the learners assume the role as co-learners in the discovery and extension of knowledge. The role of the teacher is therefore to lay foundations that enable learners to embrace the spirit of wanting to learn, rather than being forced to learn.

2.6 Criticisms of Pragmatism

There are a number of criticisms of pragmatism as a line of thinking. These include a view that it reduces ideas to a doctrine of pure expediency in attaining unquestionable ends (Woodbridge, 1904) and a failure to distinguish the notion about the consequences of the truth of a proposition and belief in a proposition (Lovejoy, 1908). Also, contemporary pragmatism as represented by Richard Rorty has been criticised by Haack (1997) and Dennett (1998) as being epistemologically relativistic and as having a short-sighted practicality similar to an ad hoc approach (i.e. an approach set up solely in response to a specific situation or problem, which works without considering wider or long-term issues).

While accepting the existence of these critics, there are genuine attributes that make the pragmatic perspective useful for this study. For example, pragmatism usually holds a neutral position in various ideological debates while establishing

its ability to engage in value-critical analysis about those arguments when necessary.

In practice pragmatism takes a middle ground between philosophical liberalism (which supports critique and reforms), and conservatism which values preserving the existing practices and the established ways of doing things (Taatila & Raij, 2012). Anderson (1987) differentiates pragmatism from liberal scepticism by describing pragmatism as "...a gentler Aristotelian form of criticism in which established practices are accepted as having inherent value but are subjected to reconsideration in the light of critical analysis and reflection" (p. 354).

To regard pragmatism as ad hoc is to neglect the fact that pragmatism in its truest sense is a philosophy in which there is no need to apologise for reconstructing principles and methods around concrete social problem solving. Given such a role, pragmatism remains an approach that is contextual, relevant and progressive rather than strictly ad hoc.

Although pragmatism in its truest sense may be viewed as a cultural global package that does not match the African Tanzanian traditional educational culture, it should be noted that African education, especially a traditional one, is both essentialist and pragmatic in nature (Fafunwa & Aisiku, 1982; Ramose, 1999). This contention solves a limitation common to non-pragmatists that usually there is a problem related to the effective and efficient application of pragmatism in non-American contexts. Despite the pragmatic limitations alluded to, pragmatism can still be regarded as a useful lens for understanding and improving the Tanzanian SE system.

In the search for practical applications of SE in Tanzania, pragmatism celebrates the synthesis of varied and sometimes conflicting ideas into useful new theories and practices. This includes combining various stakeholders' voices together with the traditional methodologies and with more critical recommendations in addressing the quality of SE in Tanzanian JSS. Pragmatism epitomizes John Dewey's idea of finding out what works best in building vital knowledge and skills among those seeking careers in science (Creswell & Plano-Clark, 2007).

2.7 Summary

This chapter has discussed the theoretical framework of pragmatism and outlined its strengths and weaknesses as a theoretical lens for exploring the quality of SE in Tanzanian JSS. The chapter also provides an overview of how pragmatism is best suited for this study than other perspectives. The chapter identifies three vital points in which pragmatism and the present study intersect. These points include the functionality, relevance and context responsiveness of SE provided in today's schools.

The chapter draws on insights on the usefulness and functionality of SE from classical pragmatists (such as Charles Sanders Peirce, William James, John Dewey, and Ferdinand Canning Scott Schiller), and assesses the relevance and context responsiveness of education according to contemporary pragmatists (such as Richard Rorty, Hillary Putman and Robert Brandom) in order to address the issues of irrelevance, dysfunctionality, context irresponsiveness and poor quality of SE in Tanzanian JSS.

CHAPTER THREE

INTRODUCING TANZANIA AND ITS EDUCATION SYSTEM

3.0 Introduction

The United Republic of Tanzania is the result of the union of two countries, Tanganyika and Zanzibar, which were united in 1964. Tanzania is one of the oldest countries known to be continuously inhabited, with areas in which the fossil remains of humans and pre-human hominids have been found dating back over two million years. More recently, Tanzania is believed to have been populated by hunter-gatherer communities, probably Cushitic and Khoisan speaking people. Among the East African countries (that is, Kenya, Uganda, Rwanda, and Burundi) Tanzania occupies the largest land mass.

The current Tanzanian population is 44.9 million people with more than 50% of people below 18 years of age and with a population growth rate of approximately 2% according to the 2012 census. The population literacy reveal 69.4% of people aged 15 and over can read and write Kiswahili (Swahili), English, or Arabic (Qorro, 2004; URT, 2012). More than 80% of the population is found in rural areas. While Dar es Salaam is the largest city and the commercial capital city, Dodoma, located in the centre of Tanzania, is the new capital city and houses the Union's Parliament. Tanzania is bordered by Kenya in the North, Uganda, Ruanda and Burundi in the North West, the Democratic Republic of the Congo (DRC) in the west, Zambia and Malawi in the south west, Mozambique in the south and in the eastern part there is a coastline bordering the Indian Ocean. The population density is largely present in the mainland with 99% of Africans (of which 95% are Bantu consisting of more than 130 tribes) and another 1% comprised of Asians, Europeans, and Arabs. In the islands of Zanzibar, Pemba and Unguja, 5% of the population consists of Arabs, Africans and mixed race Arab-African.

Tanzania's average GDP growth per year between 2000 and 2012 has ranged from about 1% to 6% respectively. The economy relies heavily on gold, tourism and agriculture. Agriculture accounts for more than 40% of GDP, providing 85% of exports and employing about 80% of the work force. Geographically, Tanzania is a beautiful country with world's three remarkable attractions, including Mount Kilimanjaro, the highest point in Africa. It also includes the three

largest lakes on the continent: Lake Victoria (the world's second largest freshwater lake) in the north, Lake Tanganyika (the world's second deepest lake, known for its unique species of fish) in the west, and Lake Nyasa (the eighth largest lake in the world) in the southwest.

Figure.1 *The map of Tanzania*

Source: <http://www.cia.gov/library/publications/the-world-fact-book/geos/tz.html>

3.1 Historical Trend of Education in Tanzania

The history of Tanzanian education can be traced back to the mid-primitive Stone Age, with Tanzanian societies living in small clans under clan heads and community chiefs. Table 2 presents a summary of the major trends that Tanzanian education has gone through to the present.

Table 2. A brief timeline of education developments in Tanzania

Era	The trend
Pre-colonial period (1860s to 1870s)	<ul style="list-style-type: none"> - The informal education system was aimed at conveying good manners, virtues, traditions and norms necessary for the youngsters' future life and creating good citizens of the specific clans and tribes in general. - The instructors were customarily elders, parents and everyone in the community
Early colonial period -German rule (1885-1913)	<ul style="list-style-type: none"> - Establishment of a three-tiered system of education (i.e. formal primary school, secondary school and vocational training) alongside the missionary schools. - The aim of education was producing clerks, tax collectors, interpreters, artisans, craftsmen, Christian converts. Generally the education alienated learners from their own traditional culture.
First World War (1914-1918)	<ul style="list-style-type: none"> -Collapse of education system due to a war which broke out between German and British troops in Tanzania. -As a result the colony was transferred to British rule.
Mandate rule (1919-1945) British rule	<ul style="list-style-type: none"> - Adoption of the German education system by British colonists who focused on educating the children of the local elite to make their policy of indirect rule work. - Education was mainly focused on strengthening the dominance of European culture, that is, total Europeanisation of the environment.
Trusteeship Period (1946-1959)	<ul style="list-style-type: none"> - A few local authorities were given power to oversee the provision of education in their respective areas and take initiatives to minimise discrimination and segregation. - The colonists were forced to create the first local Ministry of Education to oversee educational matters.
During independence (1960-1966)	<ul style="list-style-type: none"> - The education system was changed to cater for the needs of the Tanzanian people and this was reflected in the educational policy Act. No. 37. - Education was free for all, not segregated and discriminatory
Post-independence (1967-1977)	<ul style="list-style-type: none"> - Drastic changes were introduced in the education system for the sake of producing skilled man power that could cover the posts in the independent state with a focus of "Education for Self Reliance". - Deliberate efforts were taken to increase enrolments, rapid expansion of schools and the abolition of the racially discriminatory education system inherited from colonists. -It is in this period when most missionary schools were nationalised.
1978-1989	<ul style="list-style-type: none"> -The government allowed the establishment of both private primary and secondary schools. - Adult education was given a high priority and was conducted all over the country. - The enrolments at this period were not stable due to introduction of school fees.
1990s - Present	<p>In the last three decades a lot has changed including:</p> <ul style="list-style-type: none"> - Increase in enrolments; - Introduction of free and compulsory primary education. - The Ministry of Education changed its name to the Ministry of Education and Vocational Training and now includes a component of training under Ministry of Labour and Youth. - The government initiated a large number of educational development plans and strategies to further develop the education sector.

3.2 Current Tanzanian Education System

As a developing country, Tanzania has experienced uneven social, political and ideological changes since it claimed independence from Britain in 1961. It has

also for the past 50 years struggled against negative factors such as poverty, disease, illiteracy and other educational challenges, all while carrying the burden of colonial legacy. Since the 2000s, Tanzania has experienced a dramatic increase in the number of JSS, nicknamed *Shule za Kata* (Ward secondary schools), as a response to almost five decades of educational development through the Primary Education Development Programme (PEDP) and the Secondary Education Development Programme (SEDP).

Some view this increase in the number of junior secondary schools (JSS) as a great achievement for Tanzania, because it has significantly widened access for students who wish to pursue their studies in JSS. However, other stakeholders and critics describe Tanzanian junior secondary schools as little more than certificate shops, arguing that their outputs are poor and do not meet national needs for skill development. So far there is agreement that the present education system in Tanzania, like many other African countries, is the outcome of the colonial education system inherited after independence (Freire, 2000; Nyamnjoh, 2012; Osaki, 1995).

Tanzania inherited a discriminatory system of education from its colonists. This system placed emphasis on a small proportion of the population who would receive primary education, with a smaller proportion proceeding on to secondary education and even fewer would attend tertiary education (Osaki, 2007). This system was known to be very academic, hierarchical, pyramidal in nature, and designed for the minority who would fill the positions then existing in government. Like other African countries, the primary education was semi-vocationalised following the “Education for Adaptation” policy of the British Colonial government (Cameroon & Dodd, 1970). Various efforts towards achieving an education system that responds to the existing educational challenges have been negatively influenced by the nature and structure of persistent British colonial thinking still in existence within the educational system (URT, 1995).

Figure 2: *Education system inherited from colonialists*

3.3 Governance and Management of the Education System in Tanzania

The education process in Tanzania is overseen by several Ministries, including the Ministry of Education and Vocation Training (MoEVT) (formerly the Ministry of Education and Culture (MOEC), the Prime Minister's Office, the Regional Administration and Local Government Authority (PMO-RALG) and the Ministry of Community Development, Gender and Children (MoCD-GC) (MOEC, 2000; MoEVT, 2009a). The education sector is subdivided into four sub-sectors, namely: Basic Education (Pre-Primary, Primary, Secondary, Teacher and Adult Education); Folk Education, Higher Education and Technical and Vocational Education and Training (Kitta, 2004; Mafumiko, 2004).

The MoEVT is the parent Ministry responsible for planning and coordinating education programmes and capacity building for both education managers and practitioners of quality education delivery (MoEVT, 2008). It is also responsible for education policy formulation, monitoring, provision of regulations and guidelines, setting standards, quality control and assurance, assessment, curriculum development and teacher education.

Following decentralisation in the education sector, the PMO-RALG has now taken on the role of coordinating, supervising, evaluating, monitoring, administering, and managing pre-primary, primary, secondary education services; the function which was previously handled by the MoEVT. The PMO-RALG is also responsible for overseeing, preparing, and disseminating operational guidelines and circulars on management and administration of pre-primary, primary and secondary education services. The MoCD-GC is responsible for policy formulation, inspection and curriculum development, facilitation, monitoring and evaluation of Folk Education. Folk Education focuses on solving immediate community problems by providing the community with necessary technical knowledge, skills and competencies in areas related to agriculture, carpentry, masonry, mechanics, handcraft, domestic science, business, market, entrepreneurship, and in other income generating activities.

3.4 Education Financing

Education financing in Tanzania is shared by the government, development partners (both multilateral and bilateral), communities, civil society organisations and parents (MoEVT, 2007; Rajani & Sumra, 2003). The contributions of the first two stakeholders are included in the government budget. The development partners participate in education financing by signing a Memorandum of Understanding (MoU) on a Joint Assistance Strategy for Tanzania (JAST) in Kiswahili “Mkakati wa Pamoja wa Misaada Tanzania (MPAMITA)”. This strategy was established to build an effective development partnership in line with national and international commitments and to aid effectiveness by strengthening national ownership and government leadership of the development process (URT, 1995).

The Tanzanian government has allocated between 15% and 19% of the budget to education in recent years, enabling the country to attain the Net Enrolment Ratio (NER) of 97.4% in 2007 (MoEVT, (2010). The education sector budget has increased over the last thirteen years from 15.3% of total budget in 1995/96 to 20% in 2011/12; this is among the highest budgetary allocation in sub-Saharan Africa (Rajani & Sumra, 2003; URT, 2010c). In fact, the budget for education has tripled over this period. According to Mkulo (2011), the government now spends over a billion dollars annually or about 20% of its budget on education. Tanzania uses this fund to develop education quality in

the country through the Education Sector Development Plan. For instance, with the implementation of the Education Sector Development Plan (ESDP) in 2002 through to the Primary Education Development Programme (PEDP) and Secondary Education Development Programme (SEDP) in 2004, a great deal has been realised in terms of access, equity, management and delivery of basic education. Another success is the growth of the number of government and non-government primary schools. These have increased from 12,142 in 2002 to 15,816 in 2010, while the number of secondary schools increased from 1,291 in 2002 to 4,266 in 2010. Enrolment in primary schools increased from 5,981,338 in 2002 to 8,419,305 in 2010, while enrolment in secondary schools increased from 328,318 in 2002 to 1,638,699 in 2010 (Mkulo, 2011; URT, 2010c).

Despite the huge achievements and investments in education as a result of PEDP and SEDP two key questions remain unanswered: 1) what have these huge investments yielded? And, 2) to what extent have these investments been translated into concrete improvements in children's competencies? The World Bank Report released in 2007 reveals that an increase in the budgetary allocation to education has not in itself been a panacea to education quality improvement. The document cites the example of the USA, which has the highest student unit cost in the world but still ranks near the bottom among OECD countries in educational quality. On the other hand, Korea spends barely half of what the USA spends, yet its educational quality is ranked among the best in the world (Martin, Mullis, Foy, & Stanco, 2012). Other countries spending less than the USA but with high-ranking educational quality include Finland, the Netherlands, Canada and Japan (World Bank, 2007; Martin et al 2012). For educational funds to be effective it is suggested having a transparent budget which would stipulate what portion goes for which purpose and who is accountable. Failure to do so is likely to present a serious obstacle for the strategic allocation of resources and hence limit efforts to provide quality education, SE in this particular case.

3.5 The Structure of the Education System

There are two channels constituting the education system in Tanzania, formal and non-formal education. Formal education is based on the old British education model, which is designed for learners in formal schools with approved curricular. Usually this type of education falls under five cycles of education.

The first cycle is a 1 to 6 year long programme (Nursery Education), the second cycle is a 7 year programme (Primary Education), the third cycle is a 4 year long programme (Junior Secondary Education), the fourth cycle is a 2 year programme (Advanced Secondary Education) and the fifth is a 2 to 5 year programme (Tertiary Education).

The current structure of the formal education system in Tanzania shows that education is still compulsory for children aged from 7 to 15 years and is categorised in the form of a (6)-7-4-2-(3-5) model, within which there are 6 years of nursery, day care centres and kindergarten i.e. pre-primary education which is found mostly in urban centres, 7 years of primary education which has Standard 1 to Standard 7 (Grades 1-7), and secondary education (O-Level) which has 2 Levels consisting of the following:

1. Four years of junior or ordinary level secondary education (O-Level) Form 1 through to Form 4 (Grades 9-12).
2. Two years of advanced level of secondary education (A-Level) Forms 5-6 (Concentrated subject combination in either Arts or Science) and three to five years of tertiary education (i.e. University courses) (URT, 1995).

In contrast, non-formal education (NFE) is comprised of educational activities outside the established formal education system that are intended to serve identifiable customers and learning objectives. This education is pursued by people who, for various reasons, have not had the opportunity to continue with formal schooling. Non-formal education in this regard is provided in the context of adult education, which is primarily concerned with the provision of adult literacy implemented under the Integrated Community Based Adult Education (ICBAE) and programmes targeting out-of-school children and youth offered through Complementary Basic Education in Tanzanian (COBET) Centres. COBET graduates have the opportunity to join the formal education system at pre-determined levels.

The out-of-school education in Tanzania is delivered through continuing education supported by a variety of programmes, including correspondence education, self-study and extramural programmes. In Tanzania, the Institute of Adult Education (IAE) has been the main planner and provider of continuing education through evening classes, self-study, correspondence courses and other various Distance Education programmes, commonly known as Open and

Distant Learning (ODL). Similarly, vocational training caters for those who do not follow the formal system of education and runs parallel to the formal sector through centres which are regulated by the Vocational Education and Training Authority (VETA), an autonomous government agency charged with the overall responsibility of coordinating, regulating, financing, providing and promoting vocational education and training.

In addition to formal schooling, there are technical and vocational schools and teacher training colleges which provide young people with skills and post-training (i.e. post-primary education, and post-secondary education trainings) all leading to either professional certificates or diplomas in business education, technical and vocational education, teacher education and health education, in which the learners gain skills to become self-reliant. The details for the formal Tanzanian education system are shown in figure 3.

Figure 3: *The education structure in Tanzania*

3.5.1 Pre-Primary Education

Pre-primary education is organised to lay the foundations of a child's knowledge, and to provide the skills and rules of behaviour that are the

prerequisites for successful progress in daily life and primary education (URT, 2006). The major objectives of pre-primary education in Tanzania include encouraging and promoting the overall personality development of the child (i.e. physical, intellectual, mental, language, moral and social characteristics and capabilities), providing the child with opportunities to acquire and develop communication, numerical and manipulative skills and preparing the child for primary school education (URT, 2006). Though it is not formalised, children aged from three to six years have been benefiting from this kind of education in recent years.

However, efforts and plans are underway to systematise the pre-primary education for 5 to 6 year old by introducing pre-schools at all primary schools (Kitta, 2004). Enrolment in pre-primary schools has increased from 638,974 in 2005 (319, 974 females) up to 925, 465 (463,837 females) in 2010, including 1,771 students with special needs. Moreover, the centres in pre-primary education increased from 21, 607 in 2005 to 34,861 in 2010. The number of teachers for pre-primary education increased from 11,148 (6,510 females) in 2005 to 16,534 (8,884 females) in 2010 (URT, 2010a). However, despite a proliferation of kinder-care centres in Tanzania, the age to start schooling, the content to be learnt and the quality of education are areas still being debated.

3.5.2 Primary Education

Primary education is the first stage of compulsory education. In Tanzania, primary education is free and every child has the right to attend. This stage of education generally occurs from about 7 to 14 years of age (URT, 2006). The enrolment statistics in this level of education indicate an increase from 7,541,208 (3,685,496 females, 3,855,712 males) in 2005 to 8,419,305 (4,216,036 females, 4,203,269 males) students in 2010 including 36,585 students with special needs. The number of primary education teachers increased from 135,013 (64,707 females) in 2005 to 165,856 (83,686 females) teachers in 2010 (URT, 2010a). The major goals of primary education are centred on providing basic literacy and numeracy for all pupils, as well as establishing foundations in science, English, Kiswahili, mathematics, social studies, life skills and religious studies. These subjects are further organised into three broad domains that are examinable at the end of primary education. These domains include languages (i.e. English and Kiswahili), general

knowledge (that is, science, social studies and civics) and mathematics (Mafumiko, 2004). At the end of Standard 7, students sit for the National Primary School Leaving Examination (PSLE), and results are used to select those who will join the government secondary school education (see figure 3). Those who do not qualify to join government secondary schools normally join the private secondary schools after passing another unique entrance examination, while the rest can go to vocational training or enter the workforce (Kitta, 2004). With the increase in enrolment into primary schools, issues such as the adequacy and competence of teachers, student performance and the general quality of education at this level also continue to be areas that need to be readdressed (MOEC, 2004a; Sifuna, 2007; URT, 2006).

3.5.3 Secondary Education

Secondary education in Tanzania is divided into two levels: ordinary level (O-level) and advanced level (A-level). At O-level a student takes at least seven subjects selected from among seventeen subjects depending on the school's bias. This includes taking the five core subjects: English, mathematics, biology, and civics, Kiswahili which are compulsory in all schools. In the second year of junior secondary education, streams emerge such as commerce, agriculture, science, arts, home economics and technical education.

In the present thesis, the phrase “ordinary secondary education level” (O-level secondary school) relates to the 4 years junior secondary education in the Tanzanian educational system. In this thesis, the phrase “O-level secondary school” is interchangeably used with the phrase “junior secondary school”. In Tanzania, junior secondary school SE is a combination of various science subjects (such as biology, chemistry, physics and mathematics), which introduce the learner to basic concepts in science.

At the end of the 4th year (O-level), students sit for examinations known as the Certificate of Secondary Education Examination (CSEE). Few schools administer the International Baccalaureate or General Certificate of Secondary Education. Less than 1% of students who pass the CSEE are admitted to 2 year A-level education, which is comprised of Forms 5 and 6 (MOEC, 2001). Those who are not admitted progress on to vocational training or professional training, or join the workforce (Kitta, 2004).

The A-Level secondary education is streamed and lasts for 2 years, during which the students study the subject combinations assigned and approved by the CSEE. Normally, three subjects make up a combination. Civic education (development studies) is compulsory to all A-level students, and basic applied mathematics is compulsory to all science students who do not study advanced mathematics. This stage terminates by undergoing the Advanced Certificate Secondary Education Examination (ACSEE) and the results qualify examinees to undertake higher education studies, vocational training; unsuccessful candidates generally leave school to enter the work force.

Secondary schools in Tanzania follow the Cambridge model of ordinary and advanced levels, both of which require 2 years of study followed by a final examination. The education at secondary level starts between the 14th -15th year of the student's life, just after Standard 7 the final stage of primary education. In Tanzania attending secondary education is considered a privilege (Osaki, 2002). Secondary school begins with Form 1 (9th Grade). Families are required to pay school tuition fees, as well as paying for books and uniforms. Experiences reveal that these fees are often quite difficult for most parents to pay.

With concerted efforts to develop secondary education through the Education Sector Development Programme – (ESDP), the number of secondary schools has increased from 1,745 in 2005 to 4,266 in 2010. Moreover, the number of Form 1 – 6 secondary school students (in both government and private schools) increased from 524,325 in 2005 (244,571 females) to 1,638,699 in 2010 (728,528 females). Form 1 enrolment improved from 180,239 in 2005 (88,559 females) to 438,827 in 2010 (198,810 females). The number of secondary school teachers also increased from 23,905 in 2005 to 40,517 (12,696 females) in 2010 (URT, 2010a).

The language of instruction changes from Kiswahili in primary schools to English in secondary schools, starting in Form 1. The use of English continues throughout secondary school to tertiary levels (Qorro, 2006). Swahili is taught as a core compulsory subject in secondary schools. Students have core subjects, which they must study in Form 1 and 2 including Swahili, English, mathematics, biology, chemistry, physics, history, geography, civics and

religion. During Form 3 and 4, students may opt either for a science major (taking core subjects which include Kiswahili, English, mathematics, biology, chemistry, physics and civics) or an arts major (taking Kiswahili, English, mathematics, geography, history, biology and civics). Optional subjects include home economics, information and computer studies, additional mathematics, music, fine art, French, Arabic, Islamic studies, bible knowledge and physical education. Graduation requires students to pass National Examinations in Form 2 and Form 4. The students need to pass the Form 4 examination in order to successfully graduate from secondary school. However, in order to continue on to Form 5 they need to score in Division 1 or 2, which are the top-level scores. The percentage of students entering secondary school is very low, comprising less than 8% of the total student population, and average class size is between 45-55 students per teacher (URT, 2010a).

As a cornerstone of academic experience at school level, the science curriculum is structured as individual subjects. At the ordinary level of secondary education chemistry, biology and physics are taught separately as core and compulsory subjects for all students in the first 2 years of junior secondary education (i.e. Forms 1 & 2). Computer study was introduced as an additional optional subject in some schools in 1992 curriculum reforms. In the 3rd and 4th years of ordinary level of secondary education, physics and chemistry are core subjects for science students, but optional for students majoring in commerce, arts or technical studies. Each subject has a syllabus which covers the subject content for four years.

At the advanced level of secondary education, students study all three subjects of their chosen major as principal subjects. These subjects are organised into combinations of three science subjects such as CBG, PCB, PCM, PGM, CBN, and CBA (where C stands for Chemistry, B for Biology, A for Agriculture, N for Nutrition, P for Physics, M for Mathematics and G for Geography). The curriculum implementation is usually guided by the time set nationally for each subject.

The maximum time set for one subject is 4 periods per week, which is equal to 2 hours and 40 minutes for O-level, and 10 periods per week equal to 6 hours and 40 minutes for the advanced secondary education level (A-level). This

structure of education indicates a smooth transition from the typically compulsory, comprehensive primary education for minors to the optional, selective tertiary, "post-secondary", or "higher" education (e.g., university, vocational school) for adults.

Secondary education in Tanzania also includes certain vocational and technical schools with syllabi that are quite different from normal junior secondary schools (JSS). There are a variety of secondary schools owners in Tanzania; some are owned and funded by the government (known as government schools), some are half funded by the government and owned by the community (known as community schools), some are owned and funded by non-governmental organisations and religious institutions (i.e.: seminaries), and some that are owned by private individuals. Among the latter, the best secondary schools are considered to be those owned by non-governmental organisations, religious institutions and private individuals. Although in recent times the students from rural areas are given equal opportunity to attend good secondary schools, the disparities between urban and rural schools are still persistent (Wedgwood, 2007).

3.5.4 Tertiary Education

Tertiary education in Tanzania is centralised nationally and is mainly offered at tertiary institutions, university colleges and universities. There are six major programmes of study; 3-5 year degree programmes, 7-12 months certificate programmes, 2 year diploma programmes, 9-15 months postgraduate diploma programmes; 2 year master's degree programmes and doctoral degrees of 3-4 years duration full time.

3.6 The Nature of SE in Tanzania

The pursuit of SE and the aspirations of young learners towards careers in science vary greatly between countries and regions (OECD-GSF, 2006). This is due to the differences in the way SE is structured, practised and evaluated (Corrigan, Gunstone & Jones, 2013). While other countries have different structures for SE, the training of Tanzanian students in science begins at Standard 3 (or Year Three) in primary school and its content advances along with the level of education. In Tanzanian primary schools, science is learnt as "integrated science" where learning is limited to basic concepts in the core

disciplines of biology, chemistry and physics. Science subjects in secondary schools are learnt in the form of “single subject matter” whereby biology, chemistry, physics and mathematics are taught separately, and grouped in triplicate they form science combinations. The four subjects are compulsory for all students up to Form 2 (year two of secondary education) but they may be optional subjects during Form 3 for those majoring in arts, and commerce.

The nature of today’s SE in Tanzania is a result of the interaction between two different cultures: Western culture and the African-Tanzanian culture. The interaction and balance between these two epistemologies determine how science is planned, practised, evaluated and monitored in today’s Tanzanian JSS. According to Osaki (2002) the status of SE in Tanzania has been influenced by three main political influences: traditional heritage, colonial heritage and post-colonial heritage. Traditionally SE aimed to inculcate indigenous cultural heritage from one generation to another. This kind of education was free from western influences and its purpose was to enable people to solve specific local problems. This form of education changed during the colonial periods to a colonial type education, as pioneered by Germany (1880s - 1920s) and the British (1920s-1960s).

Osaki (1995) contends that colonial education was designed not only to invalidate traditional science knowledge by inculcating western science knowledge at the expense of traditional science, but to also create the demand for western science and technology. While during the post-colonial period there were a few notable efforts to contextualise SE practices for the sake of addressing specific Tanzanian challenges, such efforts have achieved little success to date due to the continued positioning of western science as superior wisdom (Osaki, 1994; Osaki, et al, 2002).

In recent decades the quality and relevance of Tanzanian SE has initiated public outcries about its irrelevance, dysfunctionality, and context irresponsiveness (Hakielimu, 2007; Hamilton et al 2010). The emergence of these complaints is attributed to the fact that the SE system has failed to make the learner self-reliant in their life endeavours. As such, it is possible that the quality of SE in today’s Tanzanian JSS has a lot to do with the colonial experiences the Tanzanian education system has gone through.

Given the role played by the JSS in Tanzania, the decision to focus this research on SE at the JSS level was also based on three major considerations:

1. JSS is an important sub-sector as it provides the middle level work force for the nation.
2. JSS is a feeder for higher levels of education, providing for students who continue through to higher education and producing quality professionals in different fields.
3. JSS is a crucial stage of life when young people begin their adolescent years and when basic perceptions and modes of behaviour start taking shape. Problems of adjustment with the new roles in life become critical and significant.

Adams (2002) describes JSS as a “basic human need, an integral part of quality of life, a support for moral and social values and an instrument for economic productivity” (p.11). Thus, this study focuses on how this level of education can best prepare young Tanzanians for the pursuit of higher education, as well as preparing them to adjust to their practical lives meaningfully and productively.

3.7 Quality Assurance Boards

Similar to other forms of education, the SE quality assurance relates to how a nation’s SE system is faring in achieving set SE standards (Van Eijck, & Roth, 2007). To ensure the quality of SE in Tanzania, the Ministry of Education and Vocational Training works together with various sectors in the provision of quality education in schools including the Tanzania Institute of Education (TIE), Tanzania Institute of Adult Education (IAE), Tanzania Education Authorities (TEA), National Examination Council of Tanzania (NECTA), Tanzania Library Services Board (TLSB), Agency for Development Education Management (ADEM), School Inspectorate Department (SID) Tanzania Commission for Universities (TCU), National Council for Technical Education (NACTE), Vocational Educational and Training Authority (VETA) and the School Self-Evaluation (SSE). These departments also oversee the quality of other forms of education in Tanzania. Table 3 summarises these important departments with their roles in SE.

Table 3. Departments for quality assurance in SE

	Category	Type of Organ	Function
Quality Assurance departments in Tanzanian SE system	Academic education	TIE	To develop curricular, to provide and oversee all forms of education with regard to teaching methods, subject objectives and standard of teaching-learning materials.
		IAE	To design, develop and implement quality training and adult continuing education to equip people with enabling knowledge and skills necessary for sustainable development and dealing with global challenges.
		NECTA	Administration of all National Examinations in the country.
		SID	Monitoring the delivery of SE, adherence to the stipulated curriculum, set standards and ensuring efficiency and quality in education in general.
		SSE	Schools continuously review the quality and effectiveness of their daily science educational practices so as to facilitate their self-improvement and further development, leading to the provision of quality education to students.
		TCU	Promote accessible, equitable and harmonised quality university SE systems that produce nationally and globally competitive outputs.
	Support departments	TEA	To solicit resources for education funds and effectively deploy the resources to facilitate SE Projects through providing loans and or grants to schools, colleges and universities.
		TLSEB	To acquire, organise and distribute books, non-book materials and other forms of information materials to individuals, schools, institutions and the public in general.
		ADEM	To strengthen the capacity and capability of all serving and future educational managers and administrators who would qualitatively improve the efficiency and effectiveness of the educational institutions in Tanzania.
	Technical education	NACTE	To oversee an overall coordination of technical education and training and establish a national system of awards.
		VETA	Coordinating, regulating, financing, promoting and providing vocational education and training in Tanzania.

3.8 Educational Challenges in Tanzania

The efforts to provide quality SE in Tanzanian JSS can be traced back to the period after independence in 1960s. The major goal was to develop a more contextual and relevant SE, thereby doing away with colonial based education. The following section presents the educational challenges in independent Tanzania.

3.8.1 Access Issues in Science Education

Access and equity concern restrictions that prevent many students having access to quality SE, or to unequal access to quality SE for some specific

groups. In most developing countries, including Tanzania, there have been problems relating to access in education, notably:

1. In Tanzania, only primary education is available to all, while secondary education is still a privilege. Fensham (2008) and OECD-GSF (2006) describe this situation as a sign of poor access in SE courses that is common in both developing and developed countries.
2. The neglect of the cultural milieu in today's school's curricular content and pedagogy (Loughran, Mulhall, & Berry, 2004; Vavrus, 2009).
3. Lower levels of successful participation of students from poor social backgrounds in comparison with students from dominant social backgrounds (Roth, & Lee, 2004).

Despite these challenges, there are successes achieved since the establishment of Education Sector development Plan (ESDP) in 2002 through the primary education development programme (PEDP) and secondary education development programme (SEDP) in 2004. This success is both in terms of access and participation in basic education. It is also noteworthy that the net enrolment rates for both boys and girls in JSS have doubled in the four years between 2004 and 2008 (MOEC, 2004b). Though this increase is a positive achievement, there are possible drawbacks associated with it, including a poorer quality of education as a result of an increase in the number of secondary schools that have not been properly managed.

3.8.2 Equity Issues in Science Education

Equity does not imply treating all learners as the same, but rather a treatment that is different but is considered equivalent in terms of rights, benefits, obligations and opportunities (ILO, 2000). In education it relates to the process in which both girls and boys are treated fairly in terms of the ages they enter the education system, achieve educational goals and advance through the different cycles relative to their respective groups (UNESCO, 2003). Equity refers to a situation whereby a person's life achievements are determined primarily by his or her talents and efforts and not by pre-determined attributes such as race, gender, social or family background over which the individual has no control (Clarke, 1983; World Bank, 2005). In this thesis equity is regarded as equal participation among learners in science studies. But in spite of efforts undertaken to achieve equity in Tanzanian education, studies by Hakielimu

(2007), Hamilton et al (2010), UNESCO (2003), and the World Bank (2011) identified a number of limiting factors including:

1. Poor and inflexible admission procedures restricted and determined by examination grades and recommendations, affecting whether students can be easily enrolled from one level of education to another.
2. Access to education being judged in terms of academic performance, or the good fortune of an individual being born within certain favoured social groups or categories, including gender.
3. Cultural practices which are still biased towards privileging boys over girls in education.
4. Presence of limited access to a good quality education based on the prevailing social hierarchy and historical patterns of socioeconomic backgrounds.

In light of such limiting factors, it can be argued that there is a need to have a proper understanding about access in education and how it can effectively be practiced without compromising the quality of SE.

3.9 New Trends and Changes in Tanzanian SE

SE is driven by complex and conflicting variables that feature rapidly growing transformations marked by new discoveries and progress in all spheres of human activity, including economic, social, cultural and political (Bull et al, 2010; Munro & Elsom, 2000; OECD-GSF, 2006). One notable consequence of these transformations is the pressure to redefine the secondary school SE practices to enable citizens to deal with the challenges in the modern world.

Drawing from this ambition it is an aspiration of most, if not all, developing countries including Tanzania to make SE contextually relevant and functional for students in solving the challenges they encounter in life (OECD-GSF, 2006; Ogunniyi, 1986 Nanda, 2003). Despite the ambition of these countries, studies reveal that the SE provided in schools in most developing countries does not offer the knowledge and skills needed for the scientific and technological development of those countries (OECD-GSF, 2006).

The poor levels of scientific knowledge and skills among the science workforce in Tanzania can also be linked to conceptually weak policies and curricular and

poor pedagogical and assessment strategies in SE (Bybee, 2010b; Hamilton et al 2010; Munro & Elsom, 2000). A similar view is expressed by, Darling-Hammond (2000; 2000c); Galabawa (1994), Mushashu (1997) and Osaki, Ottevanger, Uiso, and van den Akker (2002) who asserts that since independence Tanzanian education has been characterised by overloaded syllabi, a high level of content abstraction, and the teaching of facts which are largely irrelevant to the Tanzanian context. This situation has increased pressure on most developing countries, including Tanzania, to prioritise quality and relevant SE (Malcolm, 1999; UNESCO, 2008).

Though the problems in SE have become more critical and have been extensively debated over recent decades, very little has been achieved in making it more functional and relevant to Tanzanian learners (Chonjo & Welford, 2001; Osaki, et al, 2004). Evidence shows that continuous efforts to assist Tanzania in improving SE have largely failed to meet the goals of equipping the students with the appropriate knowledge and skills to meet challenges in agriculture, health, industry, housing, transport, and communication (Ottevanger, et al., 2005; Osaki et al, 2002). Along with this Tanzania has witnessed mass failures in the JSS national examinations (NECTA, 2010; 2011). For example, the National Form 4 Examination results in 2004, 2005 and 2006 saw high failure rates in Mathematics, at 70%, 77% and 76% respectively.

An important factor in the failure to achieve quality SE in Tanzanian JSS is related to the assistance offered by Western countries whose support has largely been to transfer forms of SE practices that are seen as “ideally working” in the developed world without any test for their practicability, credibility and desirability, or sustainability within the specific context of developing countries (Mafumiko, 2004; Ministry of Education and Culture (MoEC), 2004; Kitta, 2004; Osaki & Tilya, 2004). These Eurocentric perspectives have prevailed due to the absence of context responsive practices in SE that would have served as contextual alternative promising frameworks to improve SE in Tanzanian JSS. As a result, the First Regional Conference on Secondary Education in Africa (SEIA), which was held in Uganda in June 2003 and attended by 15 South African countries, highlighted the need to re-examine quality issues in secondary education in Africa. An outcome of this conference was the

development of the motivation to achieve quality SE through making it culturally inclusive, relevant and context responsive.

3.10 Summary

This chapter provided contextual information about Tanzania and its education system by describing the context for this thesis. This chapter provides an overview of how the education sector in Tanzania is organised, developed and monitored. Gaps in different Tanzanian education sectors are also identified, including problems related to the access, equity and quality (that is, relevance, functionality and context responsiveness) of SE. The chapter highlights how recent educational legislation regarding the right to an education and the focus on access may mask issues of quality. The next chapter reviews recent relevant literature in relation to quality science education.

CHAPTER FOUR

DISCOURSES AROUND QUALITY SCIENCE EDUCATION

4.0 Introduction

This chapter focuses on international debates around quality science education. These debates centre on global and national discourses about the meaning, structure, and approaches to understanding quality SE. The chapter also discusses new developments in the effort to provide quality science education, and the arising need for quality SE in Tanzanian JSS. Although some studies do not necessarily come from the field of science education, they are included in this review as they explicitly explain the quality gaps, issues and challenges that the Tanzanian education sector is facing, and as such may similarly affect the provision of quality SE.

4.1 Defining the Concept of Quality Education

The concept of quality education has been given many different interpretations and meanings throughout history, yet its core meaning and purpose remains elusive and context dependent (Hakielimu, 2008; Sifuna, 2007; Sumra & Rajani, 2006). This is because the concept of quality education is multifaceted, with different connotations and contradictory positions (Fraser, 1994; Thomas, 2003; UNESCO, 2007). Bishop and Berryman (2006) and Tikly and Barret (2007) attribute such illusiveness and the multifaceted nature of quality education to be grounded in the context and culture of a particular setting; factors which also contribute to the uniqueness of a country's education system.

Focussing on the purposes of quality education, Houston (2008), Srikanthan and Dalrymple (2007), UNESCO (2006) and Harvey (2002a) describe the concept of quality education with reference to three major measures: the acquisition of measurable knowledge, skills, and attitudes among learners; serving the economic goals of the community in which learners live; and reflecting the broader social relevance of the education provided. The last two criteria for quality education are now defined as relevance (Holt, 2000; Downes, 2005) or external quality (UNESCO, 2005).

The journey towards provision of quality education in different countries has been faced with an emergence of different frameworks that are used to describe

the concept of quality education. For example, while Mosha (2000) and Osaki, (2000b) regards quality education as a degree of goodness or excellence, Lomas (2002) regards it as a degree of fitness to what the educational beneficiary wants. Unlike UNESCO (2005), which describes the concept of quality education in terms of its ability to deliver satisfactory human fulfilment and to prepare learners to master their educational challenges and contribute to social progress and social change, others view quality education (SE in this particular case) in terms of student learning outcomes and the pedagogical characteristics (such as learner centred, participatory, and engaging classroom features) that are associated with these outcomes (Osborne, et al., 2002; Rennie & Parker, 2000). Unlike the latter view, the studies by Holbrook (2010) and Kolsto (2001) describe the quality of education in science as a process and outcome in which there is patterned and structured thinking that is valuable, well-organised, professional, proficient, helpful and useful to meet contemporary life challenges. This means that quality SE from this perspective requires more than just making multiple connections between new science ideas and old ones in the process of restructuring radical thinking.

According to Cosijn and Ingwersen (2000), Downes (2005) and Hjørland (2010), the delivery of quality education is possible only if the issues of relevance and the usability of the learning process are considered as the essential focus. This means that if the term quality is considered from an educational viewpoint, the quality of learning would be related to what learners have gained from school and the usefulness of what they have learnt in their educational journey (Scheerens, 2000; OECD, 2004; 2007).

The literature shows that the understanding of quality education differs greatly. Table 4 describes how divisive the emphasis and the understanding of quality education have become in recent decade.

Table 4. A summary of approaches for understanding quality education

Type of Approach or model	Central Focus	Founder and year of its development
Learner centred	<ul style="list-style-type: none"> -Learning processes -Teaching and learning methods, the learning environment, as well as organisational dimensions of the system are necessarily conceived as being learner-centred. - Principles of inclusiveness, equality and equity inspired by the Convention on the Rights of the Child (CRC) perspectives. -With a similar vision to a model of Child-Friendly Schools (CFS) developed by UNICEF (UNICEF, 2009). 	UNESCO, 2006; UNICEF, 2000; 2007 Pigozzi, 2006. Mahlaba, 2006 Hodson, 2014
Input-Process-Output	<ul style="list-style-type: none"> - Industrial vision of educational production. - Quality of educational “products” and the “performance” of education systems, learners’ characteristics, pedagogical factors, facilitating inputs, outcomes and the context. 	<ul style="list-style-type: none"> -EFA Global Monitoring Report (GMR 2002) - Heneveld & Craig (1995), OECD (2003), and Scherens (2002)
Multidimensional Social Interaction	- Sociological perspective (local stakeholders’ perspectives) that involves multiple perspectives of diverse groups of stakeholders in a specific context at a given time.	Tikly (2010)
Others	-Effectiveness, efficiency, equity, responsiveness, relevance, and sustainability of education practices.	Nikel & Lowe, (2010)
-Nickel & Lowes’ model	-Defines quality in terms of three major concerns: <ol style="list-style-type: none"> 1. <i>Contextual factors</i> (historical, socioeconomic, political, and cultural) that shape education policy 2. <i>Stakeholders’ perspectives</i>, including those of teachers, learners, parents, policy makers, non-governmental organisations). 3. <i>Enabling environment</i>, including enabling policy environment, enabling home and community environment, as well as school enabling environments. 	Tikly & Barret (2007) and Tikly (2010); O’Sullivan, 2006).
-Tikly & Barret (2007)		
-UNESCO Santiago model	<ul style="list-style-type: none"> -Adds the dimensions of effectiveness, efficiency and equity to the proposed model by Nickel and Lowe, (2010) -Stresses the dimension of relevance of education that is, <ul style="list-style-type: none"> - its responsiveness to societal concerns; - its pertinence to the daily conditions of individual learners, their families and communities. 	UNESCO (2007) Onwu, & Kyle, (2011)

Though there are differing views on what constitutes quality education, there are some shared understandings about it, especially in terms of what should be expected out of it (Curtis & Boulton, 1968; Downes, 2005). The difference that is noted in stakeholders' views about quality learning is believed to emanate from the perspective used to define the concept of quality education (Mushashu, 1997). Some educators are convinced that to understand the debates in quality education there is a need to understand the concept of quality education with a multiple view based on its usefulness and relevance in a particular setting (Ogunmade, 2005; Trohler & Oelker, 2005).

4.2 How has the Concept of Quality Changed over Time?

Looking at the etymological meaning of the term quality, it is clear that the scope of quality has been changing over time (Harvey & Green, 1993; Hakielimu 2007; Malekela, 2000). The studies by Ng (2009) and Sallis (2002) confirm that the concept of quality has gone through several waves of change. These include:

1. First wave: Focused on inspection of product or service quality.
2. Second wave: Shift of focus from product quality towards process quality
3. Third wave: Introduction of the concept of quality assurance, which was introduced with a focus on the quality of the organisation.
4. Recent wave: Shift of focus from general focus of issues to specific issues that affect everyone within an organisation.

The literature reveals that globally the education sector has also experienced a similar evolution in the definition of quality. The wave for quality education reform has mainly focused on internal effectiveness, with efforts made to improve internal school performance, particularly the methods and processes of teaching and learning in classroom (Duit & Treagust, 2003; Lomas, 2002). Over the last two decades the education sector has undergone another quality education reform focused on the interface effectiveness in terms of education relevance, stakeholders' satisfaction, and market competitiveness (Nikel & Lowe, 2010).

Today the education processes and reforms, especially the SE related ones, are challenged by the constant changes in the education environment, world-wide competition, globalisation of markets, high customer demands, changing

educational stakeholders, and the long-lasting impacts of information technology, global economic instability, and strong demands for economic and social development (Bull, Gilbert, Barwick, Hipkins & Baker, 2010; Millar & Osborne, 1998). In the pursuit of new visions and aims at different levels of education the need for life-long learning, global networking, international outlook and the use of information and technological power has arisen to ensure that the aims, content, practices and outcomes of education are relevant and functional for present and future generations (Nickel & Lowe, 2010; UNICEF, 2009; UNESCO, 2005). The emergence of these new developments reveals a shifting focus regarding quality education.

The shift towards the provision of quality education has become an essential component of education in today's schools, because the quality education system has been identified as a central enabler for individual learners being able to respond appropriately to a variety of social and cultural challenges (Education Queensland, 2004; Holt, 2000; Kubow & Fossum, 2003).

4.3 Science Education in Today's World: Structure and Goals

Science education is a field concerned with sharing science ideas with individuals, and not only targeted scientific communities but also the non-scientific community (Kola, 2013; OECD, 2007). The targeted individuals in this case include learners at all levels of education. The SE includes informal and formal SE, both of which are intended to facilitate the acquisition of relevant science knowledge, skills and attitudes that have intrinsic value and also help to address important human goals (Osborne, 2006; OECD, 2001; 2004). Unlike formal science education which is included in the school curriculum, informal science education occurs outside the formal school curriculum in places such as museums, hands-on centres, science centres, zoos, botanical gardens, the media in form of TV shows, and community-based programmes (Millar & Osborne, 1998).

SE practices worldwide show that the structure of SE has remained relatively unchanged for the last half-century, and also that its practice has been similar worldwide (Tytler, 2007). For example, SE has always been provided through distinct disciplinary strands, such as biology, chemistry and physics; strands which are operationalised as relatively constant components of science

education. Research evidence towards the end of twentieth century has revealed that in the three aforementioned strands of SE, the central focus of SE has been on three basic concerns, and two of which have traditionally been framed as more important than the third. These concerns are developing conceptual knowledge (content), developing procedural knowledge (how to do science) and the nature of science (learning about science). Historically, questions about the nature of science have been framed as less relevant, however currently, and internationally, curricular are giving the nature of science a bigger focus. (Bull, Gilbert, Barwick, Hipkins & Baker, 2010; Marsh & Willis, 2003). This focus is one which is still shaping most science classrooms today.

Both UNICEF and UNESCO recognise five major goals for quality education (SE in this case) which include: acquisition of survival skills; supporting the objectives of peace, citizenship and security; development of cognitive, emotional and creative capacities among learners; promoting equality, and seeking to pass global and local cultural values down to future generations (UNICEF, 2000; 2009; UNESCO, 2005). Underpinning the view by UNESCO and UNICEF is the economic, socio-cultural, political and technological developments in today's world, which are increasingly described as shaped and directed by science and by quality SE in particular (Heneveld & Craig, 1995; Osborne & Dillon, 2008). This means that most socio-political, economical, scientific and technological developments in today's world depend on the quality of SE that each country is able to provide to the current and future generations of its citizens.

Despite clear and well-focused intent to strengthen the scientific knowledge base among the public, experiences reveal some limitations related to the way this is practised in schools. For example, instead of making sure that science students are provided with quality SE experiences, practices in schools still seem to be limited to the following: preparation of students for examinations at the expense of developing conceptual knowledge about science, the absence of practical work experience in some of schools in developing countries - a situation which limits the students from developing procedural knowledge in science - and the absence of clear delineation about the nature of science and its relationship with other disciplines (Hipkins et al, 2002; Tytler, 2007).

The prevalence of these challenges is argued to greatly impede the provision of quality SE, a criterion which is necessary for developing strong scientific community and skilled manpower in the field (Hodson, 2011; Uwezo, 2010). According to Bybee (1993) and Osaki et al (2004) the development of scientifically skilled manpower is only possible when the provision of quality and relevant SE is a central concern. This situation explains why various strategies are being put in place in developing countries to ensure their citizens are scientifically literate (World Bank, 2011).

However, to achieve public scientific literacy and benefit from a well performing SE system, it is no longer helpful to think about quality merely in terms of maintaining standards (Stensaker, 2007). Instead, Srikanthan and Dalrymple, (2003) suggest taking a developmental approach to quality as pragmatists articulate. This developmental approach would exist in the form of multi-involvement practices, where policy makers and planners, educators, communities, parents, teachers, students and other stakeholders in educational decisions are involved in a strategy for creating relevance, ownership and accountability for their children's education.

4.4 The Ideal Features of Quality SE: International Perspective

The nature and the structure of quality SE are among the most debated aspects in the field of SE all over the world. Bull, Gilbert, Barwick, Hipkins and Baker, (2010) and Schreiner and Sjoberg (2004) relate quality SE to its ability to develop scientific literacy (bearing a utilitarian, economic, socio-cultural and democratic rationale) and enabling the learners to competently face the challenges in a modern world of science and technology. On the other hand, Osaki (2000a) and Windschitl, (2009) describe quality SE in terms of its ability to develop future scientists and address the needs of the majority; those who will not continue with formal SE to higher levels.

While a strong commitment is important in achieving the world class standard in SE, several discussions have placed a need to reflect on best ways to enact SE. Some of these ways include the commonly known practices which are also identified as the *Science Education Standards* (American Association for the Advancement of Science {AAAS}, 1989); and echoed in the studies by Bybee, 2006; National Research Council (NRC), 1996) and Reddy (2006). In light of

these studies, quality SE is therefore judged in terms of its ability to perform the following list of functions:

1. Providing criteria to judge progress toward a national vision of learning.
2. Setting criteria by which the stakeholders can make judgments to decide which curriculum, staff development activity, or assessment programme is appropriate.
3. Monitoring how much and how well children learn and the extent to which their education is translated into a range of personal, social and developmental benefits.
4. Strengthening policies in bringing efficiency, consistency and improvement of all national science programmes.
5. Preparing all students as scientifically literate citizens and preparing students who are interested in carrying on with science in senior school and into science related professions, especially for those whom science will become a lifelong vocation or avocation.
6. Enabling the public to make personal and community decisions about issues in which scientific information plays a fundamental role.
7. Developing the nation's technical and scientific abilities among its citizens, aspects which are vital for its economic competitiveness.
8. Preparing learners to enter scientific careers and to contribute in providing the country with a scientifically literate population that can address the global challenges that humanity now faces
9. Identifying and developing learner's potentials and how it may contribute to the development of the country's human resources.
10. Guiding the nation towards a scientifically knowledgeable society.
11. Building on best practices of SE and taking the learners beyond the constraints of present structures of schooling toward a shared vision of excellence and;
12. Describing a vision of a scientifically literate population.

This overview presents a challenge in thinking about how these SE standards can appropriately be translated into Tanzanian quality assurance control systems so that the Tanzanian SE system is able to successfully provide and oversee the quality and relevance of SE in the Tanzanian context. In part, this challenge is addressed in the studies by AAAS (1989), Goodrum, Hackling and

Rennie (2001p.vii), National Research Council (1996), BouJaoude (2006) and Ogunmade (2005), who consider a number of standard criteria as being important in describing contextually relevant SE for most JSS. These criteria include:

1. The science curricular being relevant to the needs of students.
2. SE being centred on inquiry and being connected with other school subjects where students can investigate, construct, test ideas and build explanations about the natural world.
3. Assessment procedures serving the purpose of learning by being consistent, valid, fair and complementary tools for communicating the expectations of the SE system to all concerned with science education.
4. The teaching and learning environment being characterised by enjoyment, fulfilment, ownership of and engagement in learning, and mutual respect between teachers and the students.
5. Teachers being life-long learners who are supported, nurtured and resourced to build the understanding and competencies required for contemporary best practices in SE.
6. Science teachers having a recognised career path which is life long and based on sound professional standards.
7. Presence of excellent facilities, equipment and resources that support teaching and learning.
8. Presence of appropriate class sizes which would create the possibility of employing a range of teaching strategies and provide opportunities for the teachers to get to know each child as a learner and give feedback to individuals.
9. Science education being valued by the community, having a high priority in the school curriculum, perceived as exciting and valuable and contributing to the personal development, and the economic and social well-being of the nation.
10. Presence of science programmes that provide students with access to appropriate and sufficient resources, including quality teachers, time, materials and equipment.
11. The presence of a safe learning environment and adequate community involvement.

12. Having a defined role for the SE stakeholders in maintaining good standards of SE. Such stakeholders may include scientists, science educators, state departments of education, local school boards, private sector, business and industry, governmental and non-governmental agencies, school administrators, teachers, parents and the students.
13. Teacher activities responding to individual student's interests, strengths, experiences and needs.
14. Having a science education system that allows students who are likely to pursue science academically or professionally to acquire the academic knowledge and skills appropriate for their needs.
15. Having a science education system that prepares informed citizens, who are ready to deal responsibly with science-related societal issues, can utilise science for improving their own lives and cope with an increasingly technological world.

These standard criteria for quality SE can be grouped into six major areas of concerns about SE: curricular, content, pedagogy (teaching and learning practices), professional development practices, education management and leadership, and assessment practices. These criteria have similar goals to that presented by Smolicz and Nunan (1975) that include “doing away with cultural inappropriateness of school science which only celebrates positivism” (the epistemological truth of science) (p.120) at the expense of recognition of the validity and plausibility of contextually promising frameworks of science education in Tanzanian classrooms. This suggests that developing genuine, relevant and functional SE experiences in Tanzanian JSS is only possible through the adaptation of some valuable and working insights from international SE frameworks into the Tanzanian context. Such translation of foreign SE standards would not only produce comprehensive, relevant practices that could guide effective SE practices, but would also help in a close scrutiny of how each foreign SE experience informs the future directions of SE in Tanzanian JSS.

4.5 Some New Emphases on Quality SE

In this modern era of information, evidence shows that some new emphases and thoughts on quality SE have emerged (Burke, Schuck, Aubusson, Buchanan, Louviere, and Prescott, 2013). For instance, there is increasing emphasis on the ‘processes’ versus the ‘products’ of science, an emphasis on

better linking science with its technological and social implications (as opposed to the current emphasis on inquiry as a predominant feature of school science), an emphasis on context and a supportive learning environments (as opposed to established approaches to teaching that favoured universalisation of science content and pedagogy). These newly emerging areas of emphasis have challenged the structure and processes of SE in today's schools (Bull et al., 2010; O'Sullivan, 2006).

The SE literature identifies a number of changing conditions and emphases in SE which altogether demand some modifications to how SE is planned, practised and monitored in today's schools. These changes include:

1. *The changing practice of science from the traditional role of the scientist.* This includes shifting from viewing science as an individually controlled pursuit to viewing it as commercial, multi-disciplinary, and technologically linked to bigger projects, which have impact on the larger community (Goodrum, Hackling, & Rennie, 2001).
2. *The changing practice on the way the public engages with and responds to science and its products.* The public has shifted from viewing science as a purely academic discipline to viewing it as a necessary undertaking for managing resources and mastering socio-economic problems (Aikenhead, 2001; Kola 2003).
3. *The increasing attacks on science as a body of knowledge.* Modern science is increasingly being attacked as being dogmatic, universalistic and for its claim as being humanity's most powerful knowledge, more 'truthful' and functional than any of the others (Symington & Tytler, 2005).
4. *The increasing knowledge explosion.* New theories are overthrowing the old ones, new science information is being assimilated into old, unverifiable hypotheses are being discarded, hypotheses supported by evidence are being treated with greater confidence, and continuously rechecking scientific results, while tentative theories are published in scientific publications. All this must be assimilated by SE (Aikenhead, 2006; Tytler, 2007).
5. *The changing nature of learning science.* This is exemplified by a shifting emphasis from teacher-centred and content-centred learning to student-centred learning (Felder & Brent, 2009; Hodson, 2014). This shift is

promising to reduce the unnecessary difficulty of school science learning to an interesting discipline of study enjoyed by all (Fletcher, 2003; Fensham, 2009; Prather, 1990).

6. *The changing audience for science education.* This is marked by a shifting emphasis from science being only for a few selected people to science being open to all. Practically, this is represented by making science compulsory for all up to high school, including those not destined for post-training in SE careers. While “science for all” remains to be important, such a desire presents a challenge of redefining the SE practices to accommodate diverse student populations with a wide range of responses towards what is essential and worthy learning in science (Bybee, 2010a; Fensham, 2011).

The implication drawn from these emerging changes in SE indicates the need to readdress the way it is viewed and enacted, particularly so that it is relevant and functional for the public (Aikenhead, 2001). Achieving this goal demands a clear and focused change to the way SE is planned, practiced, evaluated and monitored. In such a process Tytler (2007) suggests it is necessary to consider the following features of quality learning: ascertaining the sort of knowledge worth knowing and its ability to serve the future needs of students as responsible citizens; accepting that educational ends are acknowledged and adapted in informing the practice; allowing that a variety of voices and interests are included when charting a way forward for relevant SE, and acknowledging the set of circumstances controlling the implementation of the whole process of providing quality SE in schools.

To deliver quality SE for a wider public, Bull, Gilbert, Barwick, Hipkins and Baker (2010), Gluckman (2011), Millar and Osborne (1998), and Sjøberg and Schreiner (2010) have tried to pave the way by identifying the need for a multidimensional design of SE, which would be able to provide high standards of knowledge about science (science literacy development) alongside development of a skilled science workforce. For example, in the Tanzanian context, this could be done by introducing a compulsory general SE course for all learners at all levels of education. While part of this course would concentrate on general issues like health, the environment, and how the world

around us can be used sustainably; the other part of science training could be designed for those destined for science careers.

4.6 The Reasons behind the Drive towards Quality SE in Tanzania

In an era of science and technology, Tanzanians will need to be knowledgeable in science to prosper in a complex and global society (TEN/MET & Oxfam, 2006; TEN/MET, 2007). This ambition is underpinned by the belief that scientifically literate citizenry is needed to make informed decisions about their nation's health, technological developments, agricultural mechanisation, nutrition, environmental conservation and food preservation which all depend upon community literacy regarding scientific principles and concepts (Knipprath, 2010; UNESCO, 2007).

All nations that have attached importance to quality SE have seen how such an ambition has played a vital role in their overall development of their specific nations (OECD-GSF, 2006). Quality SE has been shown to contribute considerably to the economic development of different nations that have considered putting an emphasis to it (Bybee & Fuchs, 2006; Dillon & Redfors, 2014). However, while this dream may have been realised in most western countries it has not yet occurred in Tanzania. This situation calls for concerted efforts to develop quality SE in Tanzania; a process which is only possible when science practices and programmes are clearly redefined, legislatively protected from any political dictates, owned by relevant stakeholders, adequately financed and constantly subjected to periodic technical consultations and reviews to ensure that they are in harmony with both local and global challenges (Nikel & Lowe, 2010; Ogunmade, 2005).

Similarly, the close relationship between economic development and the delivery of quality SE has encouraged most developing countries to start rethinking ways they can best deliver quality SE in their schools. For example, towards their journey for such reforms, Tanzania has found itself being confronted by the challenge to produce professionals who can generate knowledge, think creatively, and solve the kinds of complex social and economic problems faced by Tanzanian communities (Hamilton et al 2010; Mrutu et al, 2005). Tanzania has found itself faced with the challenge to address not only the needs of an increasingly complex, technologically-driven

economy but also to produce professionals who can help the country caught in three development enemies, namely: ignorance, disease and poverty (URT, 1996). Another challenge is the outcry from Tanzanian education stakeholders who are demanding that SE provided in schools have relevance to the Tanzanian context (Osaki et al., 2004). Responding to such demand is likely to enable the SE system become context responsive and useful to the Tanzanians.

Tanzanian science educators are consistently calling for a more pragmatic approach towards SE reform, including a substantial change in the way SE is practiced, managed, and evaluated in today's Tanzanian JSS (JICA, 2009; Kalolo, 2010; Osaki et al., 2004). As such, efforts towards quality SE have been diverted to focus on identifying the vital capacities learners need if they are to become well-functioning members of society amid the uncertain terrain of the twenty first century (Bybee, 2006, Osaki et al., 2004). In the process of making sure that quality SE experiences are provided in schools, several questions are important to answer; what type of knowledge is worth knowing? What type of people does Tanzania want to produce? How can SE be organised to address the current and future challenges of life? These questions reveal a widespread concern about the relevance and outcomes of SE in schools (Bull et al 2010; Fraser & Walberg, 1995; Hamilton et al 2010; Stoll, de Feiter, Vonk, & van den Akker, 1996; Stronkhorst, 2001).

Similarly the studies by Bolstad (2011) and Gluckman, (2011) argue for the necessity to have SE visions focused on the students' sense of identity, self-reliance, effective and creative thinking, team work skills, and the affective aspects of student learning as determined by engagement in on-going learning. This view is advanced in reports by Chonjo, et al. (1996), Miller and Osborne (1998), and Tytler (2007), all of whom reveal some attempts to refocus SE by developing students' capacities to solve their contextual challenges through the application of learnt science knowledge.

This suggests that it is therefore important to improve the quality of SE in JSS, because this level is a vital stage; it not only serves as a link between what children have already learnt in primary school, but also accords them with an opportunity to acquire knowledge that would assist them in the development of

critical and analytical thinking about the world around them (Cornell, 2010). From a similar perspective, Moja (2000) and Dillon and Redfors (2014) argue that quality education at this level serves to both prepare pupils to exit school with skills necessary for employment or to continue with academic careers in higher education.

4.7 The SE in Tanzania: The quality gaps

As modern civilization has developed, there has been a need for improving the quality and relevance of science education in every country in the world (Osborne & Dillon, 2008; Onwu, & Kyle, 2011). In the Tanzanian context there have been a variety of projects initiated to improve the quality of SE, all of which have focused on improving the way SE is enacted in schools (Chonjo, et al, 1996; Kitta, 2004; Mafumiko, 2004; Osaki et al 2004). In many situations, however, these projects were limited by scope and duration, were teacher-centred rather than learner-centred, and (as the next chapter addresses more fully) came from a western guided perspective. As a result, these projects have not impacted positively on students' learning experiences (Osaki, 2004a; 2004b; 2007).

It is also evident that while Tanzanian researchers' efforts to improve SE have produced little impact, the government can also be blamed for assigning limited amounts of resources to SE, practices which together have ultimately led to the weak scientific and technological foundations of SE in the country (Hamilton et al., 2010; Kalolo & Kafanabo, 2012). It is perhaps surprising that in this global era, where SE holds the first priority in socio-economic development, Tanzania still embraces weak SE curriculum frameworks which have failed to capture students' interests in SE, and to sustain their desires to learn science throughout their lives (Meena, 2009; URT, 2007).

Unlike the poor trend of SE in Tanzania, evidence also shows that there has been growing demand for the public to engage with science and applications of science in the form of rapidly developing technologies such as computers and mobile phones (Hamilton et al., 2010; Hjørland, 2010; Schreiner & Sjöberg, 2004). However, SE practices in schools are still focused on the preparation of students who know and "can consume" large amounts of scientific information, but are unable to develop the creative and innovative skills necessary for their

survival nor are they able to use the learnt knowledge to address and possibly solve science related social issues (Andres & Mattias, 2006; Gray 1997; Osaki et al, 2004). Tanzanian SE is also blamed for its failure to develop individual learners into sound, effective citizens and self-dependent individuals who are able to respond to the contextual pressures and overcome the existing challenges (Osaki & Njabili, 2003; United Republic of Tanzania, 1995). The picture gained from identifying these challenges suggests that these crises cannot be solved by using a straightforward puzzle-solving methodology. Rather a diverse and pluralistic approach is needed to redefine the ways in which SE is enacted in schools, which in turn will make Tanzanian SE more functional for society at large (International Technology Education Association {ITEA}, 2000; Lyons, 2004; Osborne & Dillon, 2008).

4.8. The Adapted Approach towards Developing Quality SE

Quality SE in this study is considered as a multi-faceted concept. Similar to the view by Campbell and Rozsnyai (2002), understanding the concept of quality demands a transparent, participatory negotiation process towards meeting stakeholders' needs and expectations in SE. This study takes into consideration the importance of differing perspectives among SE stakeholders, because each is able to present their specific understanding of what constitutes quality SE. This consideration is based on belief that finding a consensus from different perspectives might help in solving the etymological complexity of defining the concept of quality SE (Tikly, 2010).

This thesis also considers the concepts of *relevance*, *functionality* and *context responsiveness* as central aspects to defining and understanding the quality of SE in a Tanzanian context. This standpoint comes with an assumption that the quality of any educational process can only be understood from the particular standpoint of a specific category of stakeholders, culture, context and the conviction of what the beneficiaries believe to be worth achieving in SE (Nikel & Lowe, 2010; UNESCO, 2007).

As stated earlier, the thesis draws on ideas from the pragmatic approach to understand and define quality science education with contextual and multidimensional perspectives. This approach is adopted because it locates the phenomenon as a multifaceted and context dependent concept, which can only

be assessed clearly from the particular standpoint of a specific category of stakeholder. The choice of this approach recognises the Communiqué of the 2003 Ministerial Round Table on Quality Education which emphasised the need to take into account the multiple perceptions of different stakeholders when aiming to reach a consensus on the desired SE outcomes and best ways to achieve them.

Given such an ambition, and given the significance of collective perspectives towards developing quality SE, this study is therefore designed with the ambition to engage various key players in SE by building a consensus that best responds to the diverse interests of the multiple stakeholders in Tanzanian JSS science education .

4.9 Summary

This chapter has highlighted discourses around quality SE and has identified some quality gaps. While conceptualising “quality” as a concept, debated by different educational proponents, this chapter also identified reasons for having quality SE in JSS. This chapter adds to the thesis that efforts to develop quality SE in schools need to consider the illusiveness of the concept of quality. The chapter has also highlighted the need to consider the differences in context, culture and stakeholder group composition, as these factors are proven to determine how such educational experiences can be relevant and functional to learners.

It is also argued in this chapter that understanding the concept of quality SE may be difficult at times, but should any attempt to appropriately address the concept be made, the reflection should be based on the criteria related to the ability of the education system to serve local community needs (relevance), and criteria addressed to meeting both global and the contextual demands, all of which need to be tied to a specific country’s own history and culture. The next chapter deals with the analysis of colonial legacy and its impact on the current SE practices in Tanzanian JSS.

CHAPTER FIVE

COLONIAL LEGACY AND ITS IMPACTS ON QUALITY SCIENCE EDUCATION IN TANZANIAN JUNIOR SECONDARY SCHOOLS

5.0 Introduction

This chapter examines the colonial legacy and its impact on current SE practices in Tanzanian JSS. The chapter discusses how colonial SE practices shape the present Tanzanian JSS science education practices. The chapter also presents the epistemological foundation of colonial SE and its impacts on the quality of SE in Tanzania and other countries colonised by the west. It also highlights the need for questioning the contribution of colonial history to the current Tanzanian SE, and draws implications for improving the quality of SE in Tanzania.

5.1 Locating western in the Tanzanian Context SE

As Wilson (1981) argues,

For science education to be relevant to a specific context, it must take much more explicit account of the cultural context of the society which provides its setting, and whose needs it exists to serve (p. 29).

Despite Wilson's contention and extensive initiatives to reform SE in non-western contexts, including Tanzania, SE has remained hegemonic, absolutist and practiced in a universalistic style that neglects responsiveness to the non-western socio-cultural contexts (Ogunniyi, 1988). SE in African countries, including Tanzania, has been criticised for lacking relevance to African cultures, for being dominated by a collection of facts from 'western' science with little or no adaptation, and for having little practical utility to its context, which leads to an alienation of non-western recipients from their environment (Porter & Parvin, 2009). Lebakeng (2010) notes that epistemological western paradigms still govern the universalistic and hegemonic virtues of colonial powers, producing a situation which denies most African learners access to and benefit from their own ways of knowing.

In the recent decade, the SE classrooms have been described as leaving no space for students and their ideas (Fletcher, 2003). Odora-Hoppers (2001) argued that SE in most non-western countries, including Tanzania, is still dominated by logical positivism with the imposition of western values, beliefs,

languages and epistemologies (Clark, 2004; Jay & Marcus, 2005). As such, Mazama (2001) argues that “we do not exist on our own terms but on borrowed European ones.... we are dislocated, and have lost sight of ourselves in the midst of European decadence and madness” (p.387). This situation has meant that there is a need to develop a ‘culture and a context sensitivity’ within science education in non-western environments, especially Africa (Onwu, & Kyle, 2011). With such an emphasis there is the potential to have SE that is relevant, context responsive and functional to the specific non-western contextual realities.

Although most debates about developing quality and relevant SE in the non-western world emanate from the western world (colonisers), there are signs of an increasing pressure from non-westerners (the colonized) to accommodate other types of knowledge within school SE (Stanley & Brickhouse, 2001). Examples of proponents of relevant non-western SE include:

1. Snively and Corsiglia (2001), who argue for the inclusion of indigenous and traditional science knowledge into the western techno-scientific knowledge.
2. Osaki (2002) who sees the Tanzanian traditional science knowledge as being more applicable to the Tanzanian context than the modern knowledge (western science knowledge), and who calls for enculturation of all scientific practices to reflect the context and culture of people in Tanzania.
3. McKinley and Stewart (2012), McKinley and Keegan (2008), Smith and Piele (1989), and Stewart (2007) who demand a shift towards addressing and understanding indigenous community concerns via indigenous perspectives and purposes.
4. Nanda (2003), who supports the idea that postcolonial societies need to develop their own “alternative sciences” as a step towards “mental decolonisation” from western mentalities.

These movements in some ways support the initiatives of having a contextually and culturally relevant SE, which is necessary for establishing the usefulness of what is taught in real-life, relating material to everyday applications and relating theory to practice (how theory can be applied in practice).

5.2 Understanding the Epistemological Foundation of Western (Colonial) SE

The current SE in Tanzanian schools is a mirror image of Western European SE. As such, the colonial SE has usually been identified by using the term Western European SE (Ogawa, 1986). The Western European SE is considered to have originated from Europe and later expanded along with European culture to its present position in the western world (Lindenberg, 2010; Ogawa, 1986; Snively, 1995). According to Ogunniyi (1988) modern science, as it is called, signifies two ideas. First, it distinguishes itself from uncivilized and ancient science, and relies on hypothetical, deductive, experimental undertakings which use objectivity to explain reality. Western science is therefore seen as the only correct path to knowledge acquisition in popular western culture. Secondly, it serves to separate the western way of thinking (which follows scientific reasoning) from so-called primitive thinking, as represented by traditional, usually non-western forms of thoughts (the colonised countries). On the other hand, some science educators have for some time viewed western SE as one of several cultures originating from the west (Cobern, 1998; Aikenhead, 1996). It has therefore been appropriate to speak about modern science under the western shadow because the West is the historic home of modern science.

The influence of western science on Tanzania began during the last half of the nineteenth century (colonial period). Garrison and Bentley (1990) labelled this period as the "golden era" (p. 188) of North American and European science education curriculum development, while Prather (1990) named it a "revolution in science education" (p. 12). During this period UNESCO and other government agencies arranged for the transfer of many of these curriculum developments to non-western, third world nations to aid technological development and modernisation. However, the attitude towards the transfer of such scientific knowledge included paying little attention to the context and culture of host countries (non-western countries) including Tanzania (Knamiller, Osaki & Kuongal, 1995; Odora-Hoppers, 2001). This process marked the beginning of substituting scientific explanations for the traditional understanding of everyday events that the majority of the non-western people were used to. These included events such as death, disease and natural disasters. In this

way, modern science was seen by the indigenous people as an alien knowledge, brought into their lives to displace their own scientific ideas and ways of knowing about nature.

In recent times, most countries in Africa have realised that the type of SE and the education in general that is being provided in schools is not compatible with their cultural and contextual needs and aspirations (Asabere-Ameyaw, Dei, & Kalawole, 2012). This realisation increased the pressure to develop context responsive educational frameworks in non-western contexts, a situation which demands the integration of non-western science experiences with the existing western science experiences.

The initiatives towards cultural and contextual sensitiveness in SE, where ideas from western and non-western science sub-cultures are shared, can be traced back to Maddock's (1981) memorable review article, 'Science education: An anthropological viewpoint' and to Wilson's (1981) article, 'The cultural contexts of science and mathematics education'. Despite such initiatives, SE in non-western countries continues to be dominated by western science. This domination is encouraged by western intellectual traditions and practitioners who tend to write themselves into the past, present and future of Africans as civilizers, saviours, initiators, mentors and arbitrators (Magubane, 2004). However, this situation has inspired science educators and experts in non-western countries to start challenging this type of education by calling for reforms to develop SE in a way that would help to make it more relevant and useful for learners in non-western contexts (Fensham, 2004; Sjøberg, 2002). The call for relevant SE in non-western contexts relates to the demand for quality and relevant SE, the main subject of this thesis.

5.3 The Linkage between the Colonial SE History and the Current SE Practices in Tanzania

Colonial (Western) science has its own values, norms, practices and beliefs and is therefore considered a culture in its own right (Davis & Martin, 2008; Greene, 2005). In the non-western context, western science is viewed as received knowledge, which is dominated by Eurocentric thoughts (Freire, 1999; Lindberg, 2010). SE researchers and educators attribute the present state of SE in non-western contexts to the legacy of colonialism, whose burdens are still carried in

non-western countries (Anamuah-Mensah et al., 2004; Fredua-Kwateng & Ahia, 2005). As such, different countries including Tanzania have realized the need to question the legacy of colonialism in the SE system for the sake of making their SE systems relevant, context responsive and functional to their people. Questioning the influence of post-colonial legacy on Tanzanian SE practices is important for two major reasons:

- It is likely to bring a sense of history into present times, and interrogates the ways colonial histories and legacies have shaped current Tanzanian SE practices.
- It is likely to help in exploring the complex layers of western/African SE relationships.

There has been extensive commentary on the dominance of colonial (western) scientific practices over non-western (colonised) science, reflecting the importance and relevance of this investigation. Commentaries include:

1. What is witnessed in SE in Tanzania and in other non-western contexts is a result of Tanzanian society being historically exploited, silenced, and their expectations and needs taken for granted in education (Dei, 2012; Osaki, 1994).
2. The current status of SE in non-western contexts, including Tanzania, is a result of the failure of western science as a culture to operate within the cultural context of the students' frames of reference and within the localised context of learning in students' daily lives (Ogawa, 1986).
3. The situation of SE in non-western contexts today is a result of a disregard of learners' traditional ways of knowing (Aikenhead & Ogawa, 2007), a situation which has ultimately led to SE becoming irrelevant to the non-western community.
4. Non-western communities, including Tanzanian communities, have given too much value to the dominant western voices, beliefs and ideologies by privileging these views over the contextual voices of society in terms of their priorities, preferences and needs regarding what they would like SE to offer (Combs, 1979; Tillman, 2002).
5. Although Aikenhead (1996) has attempted to show how western and non-western SE can be related, there are no clear grounds whereby non-

western students' science experiences can be linked to the western understanding of science so that the two epistemologies can be blended together (Odora-Hoppers, 2002).

6. The imbalance between western science and that from the non-western context is a function of recent western researchers; their positions, roles, and identities have blinded efforts of looking at problems with non-westernised frames of reference (Chapman, 2007; Stanley, 2007).

These commentaries show that the two kinds of knowing (non-western and western) have been incorrectly applied, amalgamated and harmonised by SE stakeholders in non-western contexts (Ogawa, 2002). Mazama (2001) identifies two major reasons for the failure to successfully amalgamate non-western and western SE experiences:

1. An unconscious adoption of a western worldview and perspective and their attendant conceptual frameworks without a serious re-examination or challenging of such ideas.
2. The failure to recognise the roots of such ideas in the European cultural ethos; a situation which has led non-westerners (willingly or unwillingly) to agree to footnote status in the White man's book (p.387).

Connected to the above, is the situation where SE in today's non-western schools has become less popular and interesting for many students (Holbrook, 2003; Krapp & Prenzel, 2011; Sjøberg & Schreiner, 2005). It is argued by Osborne et al (2003) and Dawson (2000) that students in today's schools seem to be motivated to learn if the science content is interesting, useful for their lives and future development and connected with their cultural and contextual everyday life. It is from this perspective that the International Conference in Science and Technology Education (ICASE) held in Penang, Malaysia recognised the critical need to increase the relevance of SE in three main areas: the perceived needs and interests of the student, industry and careers, and the needs of society, or the culture (ICASE, 2003; Onwu, & Kyle, 2011). This idea is similar to the process of discouraging all sorts of knowledge that encourage racism, domination and exploitation of African ways of knowing (Freire, 1985). The process could start reforming SE to reflect the cultural norms and contextual challenges of non-western societies and hand over the power to

indigenous communities to address their life experiences using science knowledge from their own cultural contexts. Nyamnjoh (2012) calls this process a “rebirth of indigenous epistemologies informed by local languages, perspectives, social values, cosmologies and worldviews” (p. 10).

5.4 Operational Impacts of Colonial forces on Tanzanian SE

The history of Tanzanian education, particularly SE, stems from the colonisation process that took place almost everywhere in Africa around the 1900s. While Tanzanians live in an independent state free from the colonising system, there are still external colonising forces in terms of (neo) colonial processes, which exist under the guise of international aid and globalisation. These forces continue to shape practices in social institutions, including secondary schools in Tanzania (Ryan, 2008). Some of these forces are summarized in the following sub sections:

1. *Alienating effect of western science.* The practice whereby western SE isolates non-western students from their own contexts and cultures (Maddock, 1983). Maddock insists that a lack of originality and non-accordance between western ideas and reality in non-western contexts have led to the discrepancy of the SE frameworks in practice, especially in non-western contexts.
2. *Distracting effect of western science.* This is a practice whereby the colonisers divert the attention of the non-westerners (colonised) from real issues that matter to their contexts to issues that are not important (Nyamnjoh, 2012). Even when there is evidence showing that such attentions are not important in the non-western contexts, they are forced to continue celebrating them. An example of this practice is SE itself; a situation whereby the western world has made the non-western world to believe that western science curricular are the best ones, even when they are proven as being not context responsive, unintelligible, ambiguous and chaotic in their implementation (Dei, 2012; Sifuna 2007).
3. *Displacing impact of western science.* The practice whereby local people’s ways of knowing are replaced with western ways of knowing, which has resulted in SE being disconnected from students’ everyday lives. This situation is aggravated by the continuous use of western science textbooks in non-western classrooms, a situation which has

increased dependence on knowledge and technology from western world (Davis & Martin, 2008; Ryan, 2008).

4. *Dogmatising the western science.* The practice whereby despite the differences in contexts, culture and science audience, western SE is presented as dogmatic and a prescribed correct and unchanging truth with the only correct epistemological grounding for understanding the world (Ogunniyi, 1988; Ogawa, 2008b). Fleer (2008) contended that there is a number of dominant frameworks in SE and though they have been used for a number of decades in non-western contexts without fruitful outcomes, no attempt has been made to query their fundamental realities, hidden agendas or their applicability. For example, the issues of content structure and focus of SE in Tanzania JSS is a critical issue, yet the Ministry of Education and the partner ministries in education have not provided an opportunity for the public to question their authenticity, the situation which is likely to help in improving the relevance of SE in practice (Gray, 1997; Newmann & Associates, 1996). The unspoken reality is that non-western education systems have failed to hold their own positions because of pressure from donor countries, who would not want certain liberative entities to be included in education thereby compromising their territories (Anzaldúa, 1999).
5. *Abstract presentation of western science.* The practice whereby science content knowledge is presented abstractly, a situation which makes it less interesting and irrelevant to the experiences in non-Western contexts. Fensham (2004) and King and Ritchie (2012) relate this practice to a process of disconnecting the non-western community from the expected SE experiences, a result which makes SE experiences uninteresting as they do not relate to the lives of non-Western communities.
6. *Supremacy impact of western science.* The practice whereby SE in non-western contexts has failed to blend with non-western experiences, leading to a situation where it is now considered as alien knowledge originating from the west. The originality of western SE described in this subsection does not lie in the appropriation of western thought per se, but rather lies in the forceful, uncritical, discriminating and imitative

identity that western knowledge presents over the non-western science during meaning making (Knamiller, 1984; Lave & Wenger, 1991).

7. *Inconsiderateness of western science.* The practice whereby the mutual relationship between western and non-western SE has been poorly articulated, resulting in the inapplicability of most of western science theories, concepts or models in non-western contexts (Fleer, 2008; Vavrus, 2009). For example, topics that relate to mechanised farming, control of malaria and many tropical diseases, ecological balance, provision of good and safe water, food preservation, development of good roads, solving the problems related to drought, small agro-based industries are likely to be more relevant to African settings than topics such as computer-assisted learning, laser beams, radio activity and many other topics that have been introduced into Tanzanian curricular.
8. *Forced importation of western SE.* The practice whereby non-westerners, due to their poor economic status, have been forced to import western SE into their countries without testing its applicability. This situation is similar to Adas' view (1989), which posits that there is increasing tendency of most reforms in non-western SE being inspired by uncritically imported western SE models. As such the uncritical importation of SE practices from the western world has led to dysfunctionality and irrelevance in inherited educational programmes that were largely imported through colonialism (Lewin, 1990; McKinley & Stewart, 2012).
9. *Hegemonic impact of western science.* The practice whereby there is total asymmetrical domination and subordination of non-western science practices by western science practices. At a classroom level this practice has forced the African child to absorb western science experiences during learning, despite them being largely irrelevant to individual life experiences (Anamuah-Mensah, 1998; Stewart, 2007).
10. *Presumption of uniformitarianism.* The practice whereby all Eurocentric scientific constructs are required to be applied consistently throughout the world (Stanley & Brickhouse, 2001). This presumption disregards the contextual and cultural differences that exist between western and non-western worlds. The knowledge based on this presumption is contested

by non-westerners, who demand knowledge applicability and contextual responsiveness in schooling (Roth & Lee 2004; Ryder 2001).

11. *Relinquishing impact of western science.* The practice whereby the majority non-western SE learners are forced to discard their values and indigenous science knowledge and adopt the western ways of knowing and thinking (Manathunga, 2007). In this context the native non-westerners' indigenous SE education practices get relinquished in favour of the western SE. The increasing pressure among non-western world to absorb and accept the science knowledge originating from the west; the practice, which is seen by stakeholders as an imposition which has caused some discomforts.
12. *Oppressive impact of western science.* The debates in SE identify the intellectually oppressive behaviours that western SE has been perpetuating. The views by Penn (1997) and Dahlberg, Moss and Pence (1999) regarding the oppressive mentality of colonial education relate to what exists today in Tanzanian JSS where students are still grouped in terms of family financial status, religion and race. It is not surprising to see that there are still schools for white students whose experiences in these schools do not resemble that of those in black Tanzanian schools (i.e. the majority of Tanzanian schools). This practice not only weakens efforts to have common standards of schooling, but also presents a negative intellectual divide among students from the same country. As such, Lebakeng (2010) argues that African intellectuals (historians, anthropologists, sociologists, educationists, historians and philosophers) must subject indigenous science to "serious epistemological appraisal by resolving the theoretical, conceptual, methodological and philosophical issues about the identity of indigenous African knowledge systems and what their ontological, epistemological, axiological basis or foundations are as science knowledge" (p. 26).
13. *Disbelief and pessimism of western science.* Western science as a culture has had a sceptical view towards non-western SE and has held an authoritative, dominant and repressive stance where its knowledge has not been questioned for authenticity or applicability in non-western contexts (Dei, 2011; Ogunniyi, 1996). Cobern and Loving (2001) and Ninnes and Burnett (2001) argue that, western SE continues to presents

itself as Eurocentric, hegemonic, universal and humanity's most "powerful" and "best" (in the utilitarian sense) knowledge system for science. In this case, students from all learning backgrounds irrespective of their diversity are compelled to accommodate western science and to believe that it is the only option for them to be able to function competently in the mainstream of the global economy (Michie, 2003). Snively and Corsiglia (2001) look at this situation as a danger for SE; they insist on creating the balance between the two ways of knowing so as to avoid the educational alienation of students from their own culture. Dei, (2012) adds that there is a need to develop indigenous perspectives from non-westerners through embedding their practices into their cultural contexts, histories and heritages.

The discussion in this subsection shows clearly the difficulties facing a country such as Tanzania (as a non-western country) in the attempt to find the opportunity or space to develop SE that is relevant, context responsive and generally of quality. Most researchers suggest that listening to the voices of the colonised and excluded non-westerners is essential to this goal, for the sake of not only creating a conscious perspective of non-western contexts and culture, but also to enable students in non-western environments to move beyond the irrelevant binaries that govern knowing in western science (Barton, Ermer, Burkett, & Osborne, 2003; Ryan, 2008).

5.5 Implications for Improving the Quality of SE in Tanzania

There are a number of implications to be considered in solving the impacts of post-colonial domination in SE. According to McLaren and Farahmandpur (2003), post-colonialism has become the new imperialism and this form of imperialism has had an enormous impact on schools as it has turned educational institutions into places that are safe from critique. This form of imperialism has been deliberately infused into SE systems in different non-western contexts with calculated effects that happen to shape the current JSS science education practices. Examples of imperialistic forms in Tanzanian SE today include the following:

1. The 'businessification' of schooling, which is becoming prevalent in the Tanzanian education system. This process is exemplified by the practice

of some schools diverting the aim of education from being a service to being a business. This process not only builds classes among learners, but limits those students who cannot afford to pay for their education to attend good schools (Ikechi & Akanwa, 2012).

2. The increase of confusion about the curricular focus caused by corporations and private book publishing companies like McGraw-Hill, Oxford, McMillan as well as some local publishers, all of which apply a western mentality in publishing the science content that is to be learnt by the Tanzanian learner. These companies have arrived with a similar educational perspectives; this practice has increased the problem of science knowledge being seen as irrelevant, dysfunctional and not applicable to a non-western context (Hjørland, 2010; Schreiner & Sjöberg, 2004).
3. The increase in confusion about the instructional language (also known as the *linguicide* problem) at various levels of education, which directly impacts efforts towards developing relevant and quality education (Brock-Utne, 2005; Qorro, 2006).
4. Support from the UN organisations and other country partners who for their own reasons have coerced educational policy in specific directions because the support they provide comes with conditions that require some structural adjustment of the education process (Samoff & Carroll, 2004a).

It has also been common in most non-western countries including Tanzania whereby western lenses have been governing the educational processes. This assertion is supported by Dei (2012) who notes that:

From curricular to pedagogies, dominant knowledge systems have been organised and inscribed through governing Eurocentric paradigms historically augured within colonial specificities ... But also the education systems and processes, as well as ideas about what counts as education, have been entrenched in the reproduction of colonial ways of knowing which concomitantly limit possibilities for many learners (p.2).

There is a need to develop the non-western-centred education which would stress notions of culture, aligning learners' histories, identities and experiences and focus on the learner's agency to bring about change in their personal and

community lives (Dei, 2012, p.14). This process is about enabling the non-western learner to become a subject in his/her own history and experience. Kember and McNaught (2007) argue that the process of reforming western SE to reflect the non-western context is important for enabling students to see how different ways of knowing can fit together and contribute to eventually becoming competent in their discipline or profession. Similar to Kember and McKnight's ideas, the studies by Gay (2000), Ogawa (2008b), Osaki (1994), and Ryan (2008) echo several needs for improving SE in non-western contexts. Such needs include:

1. Building acknowledgement of the legitimacy of the cultural heritage of different ethnic groups, both as legacies that affect students' dispositions, attitudes and approaches to learning and as worthy content to be taught in the formal curriculum.
2. Harmonising and bridging the home and school experiences as well as between academic abstractions and sociocultural realities for meaningful learning.
3. Incorporating multicultural experiences, resources and materials in all subjects and skills *routinely* taught in schools.
4. Empowering non-westerners to own and use their own knowledge to address their contextual challenges.
5. Identify the continuing legacy of science education's colonial practices, and problematising the notions of relevance, functionality and cultural responsiveness of SE in the non-western contexts.
6. Analysing of the aspects of universalism or multiculturalism to identify their hidden ideological and hegemonic assumptions so that SE becomes relevant in non-western contexts.
7. Creating a ground for argumentation that would enable educators to witness how dominant perspectives in the field of SE have influenced and shaped the structure and status of the today's education system.
8. Directing and guiding concerted efforts towards alternative experiences in SE and readdressing the taken-for-granted practices that either consciously or unconsciously influences the way SE is enacted in today's schools.

9. Adapting transculturation whereby subordinated, marginalised and colonised communities can select and invent new ways of learning science from the materials transmitted to them by the dominant western groups. Transculturation could also be done by selecting some practices from western countries that non westerners find useful and seek to blend with their indigenous science knowledge and ways of knowing.
10. Challenging the implanted colonial practices in SE. This includes questioning the commonly attached features of western science as being objective, value free and context independent.

Looking at these challenges there is an evident need to not only encompass facets of cultural and contextual knowledge, but also to enhance the sovereignty and cultural survival (a process of healing and rebuilding indigenous nations oppressed by colonisation) (McKinley, 2007). While some attention is now being paid to education in science from a cross-cultural perspective, there is much more to be done with respect to developing relevant, functional and context responsive SE.

5.6 Summary

This chapter has shown that modern western science is a newly imported phenomenon in the cultures of most developing countries, including Tanzania. The western science knowledge has been implemented in non-western contexts for the interests of the west. Such interests include: knowledge domination; authenticating the western science in the expense of non-western knowledge; and universalization of science knowledge. These interests have dominated the structure of western science which for most part, it has been imported to the non-western contexts in western packaging.

The discussion presented in this chapter considers the need to readdress the hegemonic nature of western SE by developing a comprehensive grand design for SE in Tanzania which would support a shift in focus for school science from students acquiring isolated bits of academic knowledge to students building a capacity to learn how to use both western and non-western science for everyday situations. While the adaption of science as a western cultural practice is necessary for non-western contexts, it is important that all imported western SE practices are either re-examined for their cultural and contextual

appropriateness, including re-examining the taken-for-granted ideas about SE in non-western contexts (colonised societies) and conversations about relevant school science reforms, including further questions about quality and relevant scientific knowledge in post-colonised societies. This process is likely to help in reducing the forceful imposition of western science experiences into the education systems of non-western countries (including Tanzania). Having discussed the global debates on quality SE in chapter 4 and 5; the next chapter presents the research methodology employed in the understanding of how best SE can be provided in Tanzanian JSS.

CHAPTER SIX

METHODOLOGY

6.0 Introduction

This chapter presents the research methodology for this study. The chapter includes the general research plan, the paradigm underpinning the study, the research method and design, discussion of the researcher's positionality, research tools, and population sampling, and the validity and credibility of the study, as well as the discussion of ethical issues and considerations.

6.1 Research Aims and Questions

Given the intentions of the Tanzanian government to improve SE in Junior Secondary School (JSS) as stated in the Education and Training Policy (ETP) of 1995, this study seeks to identify the promising practices in SE as a means towards improving the quality of Tanzanian JSS SE. The study uses perspectives from international literature and key local stakeholders such as educators, policy makers, parents, students, science alumni and selected education officers to answer four specific research questions including:

1. How is quality SE understood and articulated by the stakeholders?
2. What do stakeholders consider as the desirable features for quality science education in today's' junior secondary schools?
3. What are the challenges that most JSS have been encountering in the provision of quality SE?
4. What approaches or strategies can be used to address the challenges of SE

6.2 Conceptual Map

The conceptual map for the present study was based on the pragmatic approach, which embraces a pluralistic view in identifying a functional system of education in the Tanzanian context. As shown in Figure 4, the map blends a collective human perspective from different viewpoints, ranging from the researcher's positionality, stakeholders' perspectives, experiences from national and international literature and the evidence from empirical studies which together help to identify promising SE practices for Tanzanian JSS. Figure 4 incorporates ideas from Goodrum et al (2001), and Rennie and Parker (2000) who consider that the meaning attached to quality SE in schools is dependent

on the way quality is defined by specific stakeholders, and the contexts in which these stakeholders are located. This structure was preferred because, unlike other possible conceptual maps, it offers a way to incorporate diverse views while dealing with issues of quality SE in Tanzanian JSS. The validity of this map is built under expectations that it will be able to explain scientific clues/phenomena in their natural settings, and produce useful science teaching (Dewey, 1938b).

Figure 4: Conceptual map for identifying promising practices for quality SE in Tanzanian junior secondary schools.

6.3 Pragmatism as a Governing Paradigm of the Study

The selection of the paradigm of the study is not a matter of free choice, but is determined by the nature of the study, including research assumptions and methodological preferences (Maxwell, 2008 p. 224). This study seeks to understand SE stakeholders' perspectives about the quality and contextual

relevance of SE in Tanzanian secondary schools. To achieve the aim, this study used a pragmatic lens as the theoretical stance, because of its usefulness in studying pluralistic research problems (Johnson & Onwuegbuzie, 2004). Pragmatists reject the idea of alignment to a single research paradigm. They recommend the use of 'what works best' in order to uncover the research problem and provide answers (Creswell, 2009; Petrou, 2007). Pragmatism was used in this study as the paradigmatic partner for a mixed methods approach because, as discussed in previous chapters, pragmatism as a world view opens the door for multiple methods to be used together, accommodating diverse world views, allowing for differing forms of data collection, different categories and sources of data, and different forms of data analysis (Creswell, 2009; Patton, 2002) (See Fig 5). This paradigm also helped in determining the types of questions to be asked, the selection of participants, how the data was collected, and how implications from the findings of this study could be interpreted. Figure 5 illustrates how this theoretical stance was related to the strategy of inquiry, research design and the research methods.

Figure 5: *An interconnection of philosophical stance, strategies and research methods of this study adapted from Creswell, 2009.*

6.4 Mixed Method Inquiry as a Research Methodology of the Study

The choice to use a particular research methodology is highly dependent on the nature of the research problem and questions (Creswell, 2009; Johnson & Onwuegbuzie, 2004; Maxwell, 2008). This study investigated a complex social problem regarding the quality of SE in Tanzanian JSS, a situation which is difficult to study using a single methodology. This study employed a concurrent embedded strategy of mixed methods. According to Greene (2002) and Onwuegbuzie and Teddlie (2003) mixed methods approach is a methodology for conducting research which involves integration (or mixing) qualitative and quantitative data in a single study, the process which is done for the purpose of developing a better understanding of the research problem under investigation. This study adapted mixed methods approach for the sake of developing a better understanding on how quality SE could be improved in Tanzanian JSS. The preference to use this approach was based on the premises that, the mixed methods approach:

- 1) Increases the construct validity of data as it allows corroboration of different sets of data to explain the research problem under study.
- 2) Addresses the offset of one methodology with the strengths of the other methodology.
- 3) Provides a far more comprehensive account of the research problem than when a single qualitative or quantitative approach is used.
- 4) Provides a multidimensional view of the data, the process which also helps in enhancing and enriching the meaning of a research issue under investigation.
- 5) Ensures that there are no 'gaps' to the information/data collected.
- 6) Provides a platform for the use of multiple worldviews to address the research problem.
- 7) Increases practical methodological flexibility in a sense that the researcher is free to use all methods possible to address the research problem.
- 8) Ensures that pre-existing assumptions from the researcher are less likely to influence the interpretations.

In the present study, the mixed methods approach was useful in a number of ways: Firstly, it enabled the researcher to analyse the situation of SE from

different perspectives, and to identify those promising practices in SE which fit well in Tanzanian educational context; secondly, it enabled the researcher to collect data from a range of respondents (i.e., policy makers, science educators and managers, parents and students), thus allowing for a pluralistic view and a richer understanding of how SE education can best be enacted in Tanzanian schools; and thirdly, it enabled the integration and combination of qualitative and quantitative methods to draw on the strengths of each, as well as framing the investigation within the best suited philosophical and theoretical position of pragmatism.

The rationale for mixing qualitative and quantitative methods was that neither quantitative nor qualitative methods are sufficient by themselves to capture trends and details in complex situations, such as SE in Tanzania. When used in combination, these methods can complement each other and lead to a more holistic analysis (Creswell, 2009; Johnson & Onwuegbuzie, 2004).

The process of integrating the two sets of data occurred at several stages including data collection (e.g., when both quantitative and qualitative data were collected on the same study), during data analysis (e.g., a stage at which quantitative data were merged with qualitative data), and/or during data interpretation (e.g., when results of quantitative analyses were integrated with themes that emerged from the qualitative data). The integration of data was carried out for comparing and contrasting the qualitative and quantitative data, to draw from the strengths of each method and to synthesise a composite and complete assessment of the topic. Four factors determined the nature of the mixed methods in this study. These factors include the timing of the integration process, the weight/priority attached to each strategy, the style of integration of data sets, and the theoretical position each method reflected (see Table 5).

Table 5: Factors Influencing the Nature of Mixed Methods in this Study

Timing	Weight or Priority	Style of integration	Theoretical positioning
<u>Concurrent</u> Both qualitative and quantitative data were collected at the same time and implementation was simultaneous.	<u>Unequal weight or priority</u> Qualitative data held more weight than quantitative data.	<u>Embedding</u> -Quantitative methods were nested within qualitative methods -Integration of data took place during data collection, analysis, and interpretation.	<u>Implicit positioning of pragmatic lenses</u> Pragmatism as a theoretical lens was both implicitly and explicitly positioned to shape the purpose of the study; types of questions asked, selection of respondents for the study, how data was to be collected and analysed and how the implication of the findings could be developed.

As argued by Johnson and Onwuegbuzie (2004), and Onwuegbuzie and Teddlie (2003), the use of the concurrent (embedded) transformative model is likely to help in gaining a broader perspective from different categories of respondents as a result of using different methods to study different groups or levels.

6.5 Positionality of the Researcher

It is necessary to ascertain the researchers' roles prior to the data collection process. Creswell (2009) argues that at the outset of the research it should be clear whether the researchers hold personal values, assumptions, and/or biases that may influence the study. It is important that the researcher's positionality is acknowledged as it has a potential influence on research, and also because clarity of positionality helps the researcher to avoid biases in interpretation (Creswell, 2009).

The researcher positioned himself as both an insider and outsider during the data collection, analysis, discussion and data interpretation. At every stage of research, the researcher brought with him the influences of his culture, personal and professional experience and cultural background, all of which had influence on how the researcher planned to address the issue of quality SE in Tanzanian JSS. The researcher approached this study using a lens of pragmatism in ascertaining ways in which SE could be best practised in Tanzanian JSS.

The researcher's interest in conducting the research emanated from existing knowledge gaps in the provision of quality SE in schools. The researcher was

also motivated by his personal initiatives to make SE interesting and motivating, as well as useful to learners in Tanzanian context. While the researcher was aware of this limitation, member checking and triangulation techniques were also used to avoid researcher's bias during data interpretation.

6.6 Research Design

The choice of research design is dependent on the nature of the research questions, and the amount of data to be produced (Bryman, 2008). This study aimed at obtaining robust and rigorous data derived from the triangulation of evidence regarding stakeholders' perspectives towards quality SE in Tanzanian JSS. In achieving this purpose, the study used embedded research design of mixed methods (see Figure 6). The purpose of this design is to provide a better understanding of the research problem by converging both quantitative (numeric) and qualitative (descriptive) data. The data collection was double phased with the use concurrent approaches in that, both data sets were collected at the same time. Creswell and Plano (2007) argued that in this kind of design, one data set provides a supportive and complementary role of the other type of data set. In this study more priority was given to the qualitative data. The quantitative data set was therefore nested or embedded within a methodology framed by qualitative data set as shown in Figure 6. The premises guiding the choice for this design included the ideas that; a single data set is not sufficient, that each type of question requires different type of data, and that different questions need to be answered. Figure 6 illustrates how the design procedures of mixed methods were organized.

Figure 6. *Nature of embedded design procedures of mixed methods (Adapted from: Creswell and Plano-Clark 2007).*

As presented in Table 5 and Figure 6 the data collection for the two data sets was executed simultaneously and more priority was given to qualitative data before, during and after data collection. In general terms Figure 6 shows that:

- The study was basically a small “quant” research nested/embedded in a big “QUAL” research (QUAL+quant)
- The study was largely qualitative supplemented by quantitative data sets.
- The quantitative set of data was framed to support and enrich the account from the qualitative data sets.
- The quantitative methods were nested or embedded within the predominant qualitative methods.

6.7 Plan of data collection and analysis

The data collection process was divided into two phases. Though the research was initially designed to require a second phase of data collection, conducting the first round made the necessity to do so evident; it revealed some key issues that were not anticipated during the first round of data collection, and which required further investigation. For example, the investigation into desirable features for quality SE in JSS was not planned prior to the first round, but emerged as a concern during the first round of data collection and became a necessary entity to be examined in the second round.

The first phase of data collection involved interviewing key sources, and a documentary review from which preliminary findings were used to supplement and strengthen the discussion in the second phase of data collection. The same questions were used for the two phases of data collection with a little bit of refining, and all of them investigated the major task of how SE could be best improved in Tanzanian JSS. Figure 7 illustrates how the research process was handled.

Figure 7. *A plan for data collection process*

Figure 6 illustrates how the phases of data collection were organised to address the research questions. Given the challenges facing SE within Tanzanian secondary schools, the embedded design of mixed methods was able to provide a detailed account on promising practices for enacting SE in Tanzanian secondary schools. Interviews, surveys in form of questionnaires, and focus group discussions and documents reviews were conducted to reveal similarities and differences between each category of respondents, and to draw out patterns and themes across the respondents' views.

6.8 The Study Area

This study was carried out in two different regions. The study involved four junior secondary schools from the Iringa region (research site B) and the

educational administrative and quality assurance officers from the Dar es Salaam region (research site A). The sites are described next.

6.8.1 Contextual Description of Research Site A

Region A (Dar es Salaam) is located in the eastern part of the Tanzanian mainland at 6°51'S latitude and 39°18'E longitude. Educational issues in the region are co-managed by the Ministry of Education and Vocational Training (MoEVT) and the Prime Minister's Office Regional Administration and Local Government Authority (PMO-RALGA). At the regional level, the PMO-RALGA is staffed by a regional education office (REO). The REO's office is staffed by district education directors and district education officers. Region A is the educational centre of Tanzania and is also home to many educational institutions such as universities, colleges and some of the most excellent secondary schools in Tanzania, most of which are private. Though Region A lost its official status as Tanzania's capital city to another region in 1974 (a move which was not complete until 1996), it remains the centre of the permanent central government bureaucracy and continues to serve as the capital city for the regions surrounding the country. In particular, the main reason for choosing this region is that it is the centre for almost all national education offices and departments and hosts most of the key data respondents (policy makers) interviewed for this study.

6.8.2 Contextual Description of Research Site B

Research site B (Iringa) is an upcountry municipal region situated at latitude of 7.77°S and longitude of 35.69°E. The region is situated in mainland Tanzania's southern highlands zone, which is comprised of Morogoro, Ruvuma, Iringa itself, and the Mbeya region. Like most urban areas in the country, Iringa has a large number of education establishments ranging from nurseries through to University Colleges. The region has over 842 primary schools of which 826 are government schools and 16 are privately owned; 242 secondary schools of which 63 are privately owned and 179 are government schools; three colleges, and four universities (BEST 2011). The total number of secondary school teachers is 3175. Similar to site A, site B could be considered a 'glass half full' when it comes to the status of science education: there has been some progress but there is more to be done. The reasons for choosing this region include that it is among one of the fastest growing upcountry regions in terms of

an increase of educational training centres for SE. Another reason for selecting this region was the possibility to expand the understanding of stakeholders' perspectives about the quality of SE in secondary schools, because it allowed for responses from stakeholders situated in remote regions. Most previous studies have been conducted in large cities.

6.8.3 Description of schools

As noted, this study involved four junior secondary schools located in Iringa municipal area. Students in these schools were aged between 13 and 17. In some schools the students were provided with boarding services including food and accommodation throughout the period of their study. Some schools had advanced level students, aged mainly from eighteen and twenty-one years. While advanced secondary school students were enrolled from across all regions in Tanzania, ordinary level students were enrolled from nearby schools within the Iringa municipal administrative area. However, due to various unavoidable reasons, including parental care, medical issues and/or financial difficulty, some students from other regions either joined directly or were transferred to a certain school by the district's educational officials.

In each school, five categories of respondents were involved in the study. They included the heads of schools, science teachers, students, parents and science alumni living in the area close to the schools. The school management in all schools was under the heads of schools appointed by the principal secretary, MoEVT under consultation with the municipal educational officer (MEO), and the regional educational officer (REO). The schools had several common challenges in similar including: Non modest buildings; lack of well-equipped laboratories and up to date libraries; lack of learning support staff members such as laboratory technicians, librarians and career counsellors; and lack of enough science teachers. Table 6 summarises the important characteristics of the schools involved in this study.

Table 6. Characteristics of the schools

Schools	Nature of the school	No. of students	School composition	School ownership	No. of teachers	Combinations offered
School 1	Boarding and a Day school	997	Co-sex education school	Government	61	Agriculture, arts and science, and commerce subjects.
School 2	Boarding school	630	Single sex education school	Government	14	Nutrition, arts and science, and commerce subjects.
School 3	A day school	460	Co-sex education school	private	60	Commerce and economics, and science and arts.
School 4	A day school	201	Co-sex education school	Government (Ward JSS)	15	Science and arts.

6.9 The Sampling Procedures

The choice of sampling approach is highly dependent on ideographic, uniqueness, and exclusive distinctiveness of the phenomenon, group or category of individuals to be involved in the study (Cohen, Manion & Morrison, 2007; 2011). This study involved several categories of respondents from different groups. To obtain the samples, this study applied simple random sampling, purposive sampling, and at some points stratified sampling, where relevant. The details of the sampling process are discussed in the subsections that follow.

6.9.1 Selection of research sites

6.9.2 Selection of Schools

All the schools for this study were purposively selected from district capital towns. Purposive sampling involves a process whereby the researcher deliberately selects respondents with some purpose or focus in mind (Punch, 2005; Cohen et al 2011). With purposive sampling the research population is less significant than the criteria of identifying appropriate respondents, since such qualitative research does not aim at generalising results (Bryman, 2008). Purposive sampling in the present study was based on the ability of the sampled category of respondents to produce a rich description about the topic. The selection of schools was done by making contacts to the Regional

Education Director and School District Education Officers to request for an approval. In each district, the District Education Officer provided the researcher with a list of all the schools, and with the help of the office staff the researcher clustered them into co/single sex education and government/private schools. Then the two clusters were subjected to several criteria for recruitment. Four junior secondary schools were sampled from the clusters. The choice of these schools was based on four factors: school ownership (government/private), school composition (co-education school/single sex education school), the age of the school's science education programme (more than five years), and its level of academic performance (high academic performance in SE). The last criteria used was the school being practical for the researcher to access, based on factors such as access to a suitable contact person in the school and ease of transportation to the school. The schools were selected to be representative of the aforementioned clusters (See Table 6).

6.9.3 Selection of Respondents

Given the constraints of time and resources, purposeful and multilevel sampling was used as it was assessed to be less costly, less time-consuming, more easily administered, and with a high response rate. Creswell and Clark, (2007) recommended that participants who have experience with the phenomenon under study can be selected to give the needed information. This is supported by Wiersma and Jurs (2005), who pointed out that the idea behind purposeful sampling is different from random sampling in that; it involves selecting a sample of rich information from the schools that are studied in detail. On the other hand, multilevel sampling design (involving different individuals in each phase and representing different levels of the population) was used to identify the units of analysis (individuals, groups, contexts in terms of settings and events) accompanied by a decision pertaining to the sample size (the number of units chosen for the study). Sampling of respondents was driven by the recognition that the provision of quality SE in schools requires cumulative insights among the stakeholders. Therefore issues and solutions for problems in SE could not be understood from theoretical approximations but were to be informed by stakeholders' experiences of and perspectives on quality SE (Creswell, 2009).

As mentioned earlier, this study employed diverse categories of respondents to gain collective opinions about how SE could best be enacted in Tanzanian junior secondary schools, as shown in Table 7. Such categories of respondents included the following:

1. *The policy makers* – members from the Ministry of Science and Technology, School Inspectorate Department (SI), a staff member from the Tanzanian Education Authority (TEA), a staff member from the National Examination Council of Tanzania (NECTA) and one member from the Tanzania Institute of Education (TIE);
2. *The educators and school managers* – science teachers, heads of schools and the District Educational Officers (DEO);
3. *The society* – selected parents from school boards, students and science alumni living in the community.

Table 7. Respondents' characteristics

Research site	Position of participants	Sector	Stakeholders	Number
Site B	Internal	<u>School</u> experiences towards provision of quality SE	Heads of schools	4
			Teachers	16
			Students	24
		<u>Academic unions</u> Professional views towards provision of quality SE in JSS	Science alumni	8
Site A	External	<u>Government</u> Departmental commitments towards quality SE education as policy makers	Tanzanian Institute of Education	1
			Iringa District Educational Officers	2
			Tanzania Educational Authority	1
			Tanzania Commission for Science and Technology	1
			School Inspectorate Department	1
			Tanzania National Examination Council	1
Site B		Community unions	Parent associations	8
Total				67

While the small number of respondents might seem concerning, it is clear that all respondents interviewed, included virtually all key stakeholders in Tanzanian JSS education. One of the strengths in this study is having these stakeholders express their personal views on the issue of quality of SE in Tanzanian JSS. With a snowball sample, the researcher thought it unreasonable to have a lot of respondents who could provide similar views about quality science education. With such an assumption, the researcher believed that fewer stakeholders could provide a more distinct discussion about how SE could best be enacted in Tanzanian JSS.

6.9.3.1 Selection of Students

A total of 6 Form 4 science students from each school were sampled for the focus group discussions (FGD). Therefore, with four schools participating, a total of 24 students were involved in the study. After a general introduction of what the research was about and what their (students as prospective participants) role in the study would be, the researcher used stratified sampling where students at grade level were stratified into science streams (Stream A, B, C, D and E) and sex (for co-sex education schools), followed by a random sampling process. Each stratum of respondents was subjected to random sampling to get a representative sample. At a stream and sex substrata the researcher provided cards equal to the number of students in that stream. Some cards were written with 'YES' and the rest written 'NO'. Each student was asked to pick one card. The students who picked the cards with a word 'YES' in each sub-stratum were included in the sample. While having the reserve list of respondents at hand, these students were asked for their consent to participate in the study. The involvement of this group of respondents was based on the following assumptions:

1. Students were also SE stakeholders; hence their arguments around the state of science education in the country and their roles towards quality SE were seen important because they have a right to be heard in matters that affect them. This fact is also supported by the United Nations Convention on the Rights of the Child (UNCRC) (UNICEF, 2009).
2. Most JSS students would have reached the age of 15 years, the age at which they are enough to likely have done some conscious reflection on

their interests, priorities and attitudes towards science-related issues and schooling.

3. The JSS is the end of compulsory schooling in Tanzania. At this stage in school, many students would have been expected to have some ideas about their plans and priorities for their future.
4. The age of 15 years is also marked as the age when many educational and curricular choices are made.
5. Lastly, the adult literacy rate, which is one of the indicators for Human Development Index is based on people aged fifteen years and above thirteen years. Therefore, it was likely that students of this age would provide consistent responses to the questions, and thereby enhance the reliability of the data.

The sample area was quite homogeneous in terms of school type, composition, location and ownership. Although the study's sample may seem small the respondents' answers proved very useful in identifying issues and promising practices for quality SE in Tanzanian JSS.

6.9.3.2 Selection of Science Teachers

The heads of schools introduced the researcher to the school's academic masters who then facilitated a meeting with the prospective respondents. Two major criteria were used to select teachers for the study. The first was that they were qualified to teach science subjects and the second was that they had no less than 3 years of experience of teaching science in secondary schools. In cases where the required number of teachers meeting these criteria was not available, the researcher used 'qualification in teaching science subjects' as a criterion to obtain the required number of respondents from pool of teachers present in a school. Four teachers were sampled from each school, making a total of 16 science teachers for the whole study.

6.9.3.3 Selection of the Heads of Schools

Prior to visiting the schools for the study, an appointment with the Head of each school was sought to gain their consent to participate in the study. One head of school from each school among the four selected JSS was sampled, making a total of four Heads of schools who were involved in the present study. The heads of schools were purposively involved in the study because of the

positions they held in their specific schools. Convenient sampling was used to select assistant heads of schools in situations where the school Heads were not available. The same process of seeking alternative interviewees where those selected were unavailable was preferred throughout the study.

6.9.3.4 Selection of Policy Makers

A total of 5 respondents representing various educational related departments were interviewed in this study (See table 7). These respondents were selected by purposive sampling and convenient sampling when it was necessary. Their selection was based on the positions held in their departments. This group, together with district educational officers, formed a group identified as 'key sources of data' that were visited in Phase 1 of data collection. Consent to participate in the study was sought prior to conducting interviews with these respondents.

6.9.3.5 Selection of Parents

Two parents from the area surrounding each school were involved in the study, making a total of 8 parents. The parents interviewed were selected from those on the school Board. The decision to include parents as respondents was because parents could directly push for greater accountability from teachers; as they became more involved with the school, they appeared to become more willing to contribute to the school. The parents were identified with the help of school management and they were introduced to the researcher by the school Heads.

6.9.3.6 Selection of Science Alumni

This study involved science alumni who were selected from retired professionals in science and role models present in society. Eight science alumni were sampled for this study. The science alumni were involved in this study with an assumption that as educational actors they would have valuable information about factors impacting education in their communities and would contribute to rational decisions regarding what to do, when and why. Purposive sampling was used to include them in study. With the assistance of the school management it was possible to identify these people around the area. Protocols of research ethical conducts were adhered to prior to and during their involvement in the study.

6.9.3.7 Selection of the Documents for Review

The documents were selected based on their ability to provide:

1. Appropriate descriptions of SE in Tanzanian Junior secondary schools, its trends, challenges and emerging issues;
2. International literature describing SE practises in other countries with similar contexts to Tanzania;
3. Case studies describing best practices for quality science education in schools, and the predominant philosophical stances that govern SE internationally;
4. Answers to the tentative questions in documentary review schedule in Appendix H.

6.10 Study Bias

Bias may play a role in this study, in that the researcher had previously been a student teacher supervisor for Mkwawa University College of Education (MUCE). Some teachers knew the researcher through his affiliation with MUCE, a place where some of them had worked with the researcher as students, friends and colleague teachers. This factor may have had an influence on teachers, students and science alumni's' responses to interview prompts, especially as some questions concerned their understanding about quality science education that reflected content which the researcher might have taught them, or shared a conversation with them about when he was a tutor.

The researcher aimed to be transparent and avoided any reference regarding his own experiences and history that could influence his understanding of the topic under discussion. The position and the role of the researcher are included in the section entitled "Positionality" (section 6.5) in this chapter, which addresses the issues of potential bias.

6.11 Research Tools

In maximising the validity and credibility of findings in mixed method research, the mixed research proponents recommend mixing the data collection tools for complementary strengths and non-overlapping weaknesses (Johnson & Turner, 2003 p. 299; Teddlie & Tashakkori, 2003). In this study, multiple research tools such as questionnaires, semi-structured interviews, focus group discussions, and document reviews were employed to collect multiple forms of evidence.

The combination of these tools led to convergent evidence, subsequently strengthening the findings of whole study.

Methods of data collection included semi-structured interviews (with multiple probes), a questionnaire, focus group discussions and document review. All instruments were written and discussed in English, except with students where code switching between English and Swahili was used when it was necessary.

6.11.1 Questionnaire

There were two kinds of questionnaires: The first category of questionnaires was administered to science teachers in selected junior level secondary schools. These questionnaires (Appendix E) presented a combination of closed and open-ended items. The open-ended questions were included to allow the participants to write more detailed responses about their perspectives towards quality SE in their schools. With a shortage of science teachers in Tanzanian secondary schools, as noted by Kitta (2004), the questionnaire schedules were completed by at least four science teachers from each school. They were distributed to the teachers by the researcher himself, with the help of school academic master. The same teachers were also involved in the focus group discussion, to discuss sensitive issues identified by the researcher in the completed questionnaires, and to gain deeper understandings.

The second category of questionnaire was provided to all respondents except students, who were excluded because of their inability to respond to questions in written English. During the first phase of data collection students were more relaxed during conversations and they were more willing to express their views verbally than they were to write them down in English. As shown in Appendix I, the follow-up questionnaire had to be responded in English, a demand which excluded students from being involved. However, for the sake of not losing important data from students, the researcher made sure that all information necessary was obtained from students during the focus group discussions. The questions in the follow-up questionnaires were included in the interviews with the students.

The aim of this second set of questionnaires was to cross check the consistency of respondents' views as obtained in the interviews and the completed questionnaires from the first round.

6.11.2 Interview

Semi-structured interviews were used to gain information from the district educational officers, officers from the Tanzania Institute of Education, the Ministry of Science and Technology, the school inspectorate department, national education authorities, school Heads, parents, and science alumni as shown in Table 8. As suggested by Boyce and Neale, (2006) semi-structured interview as a qualitative research technique was used in this study to undertake intensive individual interviews with a small research population, in this case to investigate their perspectives on quality SE in schools. While being aware that semi-structured interviews have the advantage of providing detailed information and a more relaxed atmosphere for data collection, the researcher was also aware that they can be prone to bias, as respondents may be informed by distortions that stem from the taken-for-granted realms of their social life (Neuman, 2006). In this thesis, interviews were tape recorded and transcribed. Each respondent's consent was sought before using a tape recorder. A total of 27 interview sessions were conducted, of which 12 were conducted in Phase 1 and 15 in Phase 2 of the data collection processes (see Table 8). The interview was guided by a schedule of open-ended questions that would provide opportunities for the respondents to freely respond to questions about the topic. The interview sessions lasted for 45 to 60 minutes per respondent.

6.11.3 Focus Group Discussion (FGD)

As contended by Krueger and Casey (2009) and Stewart, Shamdasani and Rook (2007), the FGD is a form of group interview where the reliance is on interaction within the group who discuss a topic supplied by the researcher. These authors supported the idea that such discussions must however be limited to a small number of issues with clearly identifiable agenda and a carefully planned discussion designed to obtain perceptions on a defined area of interest in a free, non-threatening environment. This study involved six science students from each of the four selected schools. According to Arbeiter and Hartley (2002), one of the reasons for using focus groups in addition to interviews is to enable a discussion about possibly controversial topics that would not come up in an interview.

The respondents were asked about their experiences of SE in their schools and for suggestions on how SE could be improved. The questions as shown in Appendix C, guided this discussion. The information obtained from FGDs provided direct collective insights about SE in schools as well as enriching the discussion of data, which would be obtained through other research instruments. Four FGDs from the four schools were conducted with students; each session lasted for 45-60 minutes. Three FGDs were largely conducted in Phase 2 of the data collection, though one was conducted in Phase 1. Before engaging in focus group discussions, a rapport was established through self-introduction and explaining the aim of the study, following which consent was sought from each respondent.

Post FGD sessions were also conducted with four science teachers in each school; who had completed the questionnaires. These FGDs took place outside school hours because it was difficult to get all the teachers together due to their teaching responsibilities. As such the FGD were conducted at times convenient to all four teachers. The aim of these FGDs was to gain clarification on issues that had emerged from the questionnaires. This FGD was a kind of post discussion held in the form of a conversation (teacher talk) after filling out the questionnaire, to gain more information on the topic from teachers who are the vital facilitators of SE in schools.

6.11.4 Document Review

The document review was done prior to the data collection process, and it included perusing government SE policy, circulars, science curriculums and science subject syllabi, as well as national and international literature including empirical research on best practices in SE. In addition to the aforementioned documents, the researcher analysed the following educational documents:

4. The 1967 Education for Self-Reliance Policy (ESR);
5. The 1982 Report of the Presidential Commission on Education (RPCE);
6. The 1995 Education and Training Policy (ETP);
7. The Education Sector Reform and Development Programme (ESDP);
8. The Basic Education Master Plan (BEMP);
9. The Secondary Education Master Plan (SEMP);
10. The Teacher Education Master plan (TEMP) of 2000

11. The Poverty Reduction Programme;
12. The New Approval System for Educational Materials;
13. The Tanzanian Development Vision for 2025.

According to Yin (2009), the most important use of documents is to corroborate and augment evidence from several sources. In this study, the use of a document review as a tool for data collection served for a number of purposes. Firstly, it enabled refining the data collection process by opening up the general research domain, and by identifying specific areas of inquiry. Secondly, it enriched the information collected through questionnaires and interviews (Yin 2009). Thirdly, it provided rich information in relation to the topic (Best & Kahn, 2006). Finally, it enabled the researcher to compare and contrast the information obtained from the analysis drawn from questionnaires, focus group discussion, and interviews (Best & Kahn, 2006). While being aware of the danger of over reliance on the data from the documents, the researcher was less likely to be misled by documentary evidence as he involved himself in the critical analysis and interpretation of these sources of evidence.

6.12 Validity and Credibility of the Thesis

As noted, this study is a mixed research study. Onwuegbuzie and Johnson (2006) argue that it is important for mixed research studies to involve combining complementary strengths and non-overlapping weaknesses of quantitative and qualitative research, and for that reason, assessing the validity of findings is particularly complex and difficult. This study used various strategies as outlined by Onwuegbuzie and Johnson (2006) to reduce any problems of validity and credibility (legitimation). These strategies include:

1. The *insider/outsider (emic/etic) legitimation* which involved an accurate presentation and appropriate utilisation of insider's and the observer's views for purposes of producing sound descriptions and explanations about quality SE. In this study emic and etic views were justified through member checking and peer reviews respectively.
2. The *weakness minimisation legitimation* in which the weakness from one qualitative method was compensated by the strengths from a quantitative method, and vice versa, as suggested by Creswell, (2009), and Teddlie and Tashakkori (2003).

3. The *paradigmatic mixing legitimization* in which the researcher's epistemological, ontological, axiological, methodological and rhetorical beliefs underlying the quantitative and qualitative approaches employed in his investigation were blended into a usable package. This study used paradigm assumptions of pragmatism and those of mixed method research by fitting the study within the stated assumptions of this paradigm.
4. The *multiple validity legitimations* in which triangulation is part and parcel of data analysis and interpretation. In this study, triangulated data from various sources was used to corroborate or refine claims. Interviews, focus groups, informal conversations, policy documents, organisational reports and field notes were used for triangulation as recommended by Creswell (2005).
5. *Political legitimization*, which involved solving contradictions, value tensions and paradoxes that arose when the quantitative and qualitative findings were compared and contrasted. This was coupled by checking for discrepant evidence during data analysis. The process started with looking for discrepant evidence and counter arguments made by respondents of this study.
6. *Methodological Legitimation*, which involved paying close attention to details in relation to the development of interview schedules, conducting interviews, recording and transcription of discussions, and coding of data, and also reliability checks.
7. *Addressing the bias* in which the researcher's bias was addressed by explicitly describing the researcher's experiences, values and assumptions that may have influenced interpretation and the conclusion drawn.
8. The *ethical related legitimization*, involving the use of peer debriefing and negative analysis of respondents views' in relation to the classification of issues identified in the international literature on quality assurance and the empirical studies , and their application to the present study.
9. The provision of thick description in relation to the research processes and contextual information, associated with the this study by employing triangulation through:
 - a. Considering data from different sources;

- b. Using multiple methods of enquiry (techniques) such as interviewing and reviewing of documents;
- c. Subjecting transcripts of the interviews to independent checks by one of my supervisors to verify if the themes identified were similar;
- d. Using open-ended questions in the interviews.

Other strategies to support the validity and credibility of the study included recording the data objectively and comprehensibly by using audio recorder, note taking and attending carefully to both the tone and the information carried in the respondents' voices. The research instruments were translated in Swahili language (the first language of the respondents) when needed by the respondents for clarity reasons. A variety of instruments, sources of data and findings were used to elucidate complementary aspects of similar themes. Supported by Best and Kahn (2006) and Pallant (2005) this study involved revising, challenging, broadening and supporting the patterns emerging from the data analysis.

Denzin and Lincoln (2005) argue that while none of these techniques could singly be said to solve all problems of research credibility and validity, when used with due regard to their limitations they can produce reputable research findings that are credible, dependable, transferable and confirmable. Given this, generalisation of the findings was not the goal of this research. It is expected that by ensuring credibility and validity, it is likely to produce credible, dependable, transferable and confirmable research findings that are likely to have potential impact on the way SE is practised in Tanzanian junior secondary schools.

6.13 Data Management and Analysis

According to Cohen et al (2011) there is no single or best way to analyse and present data. Therefore the choice of technique to manage and analyse data depends on the fitness for purpose. This study employed various techniques in managing and analysing its data, as suggested by Bryman (2008). The details of these techniques are discussed in the subsections that follow.

6.13.1 Data Management Procedures

This study employed both multi-dimensional and reflexive approaches (multiple strategies) of data management procedures, geared at reduction and

organisation of a huge body of data to produce informative results. The field data, in hard copy, was stored in a lever arch file. The file had dividers with labels site A and B. These files were kept in a locked cabinet at the researchers' university office, accessible only by him. A soft copy of the same data was saved in the researchers' laptop, and in the researchers' password protected computer, as consistent with Victoria University ethics requirements. Even after transcription, the raw data remains stored in a password protected document for continued reference.

While pragmatism remained the lens for meaning-making in this study, the process of data analysis involved a combination of the following seven phases of mixed methods analysis, as shown in Figure 4:

1. *Data reduction* which involved reducing the dimensionality of the qualitative data (e.g., via exploratory thematic analysis) and quantitative data (e.g., via descriptive statistics such as means, modes, frequency and standard deviations);
2. *Data display* which involved describing qualitative data pictorially (e.g. matrices, charts, and figures) and quantitative data (e.g. tables and charts);
3. *Data transformation* which involved quantitative data being converted into narrative data that could be analysed qualitatively (qualitized) and/or qualitative data converted into numerical codes that could be quantified;
4. *Data correlation* which involved quantitative data being integrated with qualitized data or qualitative data being integrated with quantised data to establish relationships among these data sets;
5. *Data consolidation* in which both quantitative and qualitative data were combined to create new or consolidated variables or data sets (different data types merged into one data set);
6. *Data comparison* which involved comparing data from qualitative and quantitative data sources (comparing data from two different sources); and,
7. *Data integration* in which both quantitative and qualitative data were integrated into a coherent whole study (i.e., qualitative and quantitative) that were analysed and interpreted simultaneously (Onwuegbuzie & Teddlie, 2003 p. 374-378).

In general terms, this study used a multi-focal lens during data analysis, discussion and interpretation to enable the researcher to zoom into microscopic details and/or out to beyond the scope of the data. A pragmatic perspective provided an opportunity to look at issues by combining macro and micro levels of research issues. The data was also viewed as meaningful in itself, while it was also supplemented with a well-grounded pluralistic meaning that could explain the prevailing contextual situation of Tanzanian SE.

6.13.2 Data Analysis

While the quantitative data from the teachers' questionnaires was analysed using simple descriptive statistics such as means and frequency expressed by percentages, with the aid of the SPSS 16.0 statistical package where appropriate, the qualitative data were analysed using thematic analysis. Braun and Clarke (2006) recommended thematic analysis for its ability to help identify, analyse, and report on patterns (themes) of data, as well as for its ability to potentially provide a rich and detailed, yet complex, account of data. Adding to this contention, Johnson and Christensen (2008) defined data analysis as creating meaning out of raw data. Thematic analysis goes beyond descriptions by interpreting various aspects of the research topic (Boyatzis, 1998). This study is situated within a pragmatic perspective in which thematic analysis is suitable. Table 8 presents a multi-layer framework for analysis of data in the present study.

Table 8. A multilayer framework for analysis of stakeholders' views on quality SE

Perspectives	Data source	Category of respondents
External perspective	Global view	International world organisations i.e. UNESCO -----Existing global practices on quality SE
		Empirical studies -----Realm of experiences about quality SE
Internal perspective	Experiences from the data of the present study	National quality assurance agencies -----Policy makers as stakeholders
		Institutional layer -----School managers and administrators as stakeholders
		Professional layer -----Science educators as stakeholders
		Community layer -----Parents as stakeholders
		Contextual layer -----The defining variables for the nature of the relevant meaning attached to quality SE
		Individual layer -----Students as stakeholders (beneficiaries of quality SE as a product) -----Science alumni as stakeholders (beneficiaries of quality education as an outcome)

6.13.3 Working through the Stages of Thematic Analysis

As suggested by Braun and Clarke (2006) and Creswell (2009) this study employed six stages of thematic data analysis which included the following:

6.13.3.1 Stage one

At this stage both visual (field notes) and audio (recorded interviews and focus group discussions) data were transcribed into written form, read and re-read with a thorough revision of the whole data, while recognising the emerging themes which later became the categories for analysis. As recommended by Creswell (2003) about data transcription, this stage entailed sorting data into different groups depending on the information sources. The researcher started with generating an initial list of ideas about what is in the data and what is interesting about the data, hence being ready for the subsequent stage.

6.13.3.2 Stage two

This stage involved the production of initial codes from the data that appeared not only interesting to the researcher, but also could be assessed in a meaningful way regarding the research tasks of the study. As augmented by Braun and Clark (2006) and Tuckett (2005) about coding, this study employed

manual coding, where the qualitative data sets were coded by writing notes on the text being analysed, using highlighters or coloured pens to indicate potential patterns or by using “post-it” notes to identify segments of data that seemed to have something of interest to the research. The coding process was theory driven, in that the data was coded around the topic with specific research questions. The stage was finalised by the researcher ensuring that all copied extracts of data from individual transcripts were coded and then collated together within each code hence marking the beginning of identifying themes for research. As argued by Miles and Huberman (1994), this is a stage of analysis that involves organising the data into meaningful clusters.

6.13.3.3 Stage three

At this stage all the data was initially coded and collated into potentially identified themes across the whole data sets. This was done by combining all codes that had similar ideas, to form themes. As Braun and Clark (2006) recommend with regard to sorting for themes, the researcher used visual representations such as tables, mind maps, written names, and brief descriptions of each code on a separate piece of paper to help sort different codes into identifiable themes. This stage resulted in theme piles which marked a starting point for thinking about the relationship between codes, themes, and different levels of themes, such as the main overarching themes and the sub-themes within them. This stage can be thought of as a *code combining stage* or a *themes forming stage*.

6.13.3.4 Stage four

At this stage it was evident that some initial codes formed main themes, whereas others formed sub-themes and others seemed to belong nowhere. Instead of discarding the latter, a special theme named ‘miscellaneous’ was created to house the codes temporarily, until enough data was found to support them. This stage was a *theme reviewing stage*, in which while some themes collapsed into each other, others needed to be broken down and separated them. As Braun and Clarke (2006) recommend, this stage involves reviewing the themes by reading through all the extracts for each theme and considering whether they form a coherent pattern reflecting a meaning evident in the entire data set, or whether they clash and don’t fit with each other.

The review of themes was done for two major purposes. Firstly, to ascertain whether all the collated extracts for each theme formed a coherent pattern and whether such identified themes worked in relation to the data set. Secondly, the review was done to code any additional data within themes that had been missed in earlier coding stages. In so doing all the potential themes were evaluated against the labels given to the themes, to determine if the data set was answering the research questions. This stage is known as a *theme refining* stage, which usually results in the reduction of the theme piles (identified in Stage three) to a few themes that directly reflect the study.

6.13.3.5 Stage five

This stage involved identifying the ‘essence’ of what each theme was about, as well as identifying the essence of themes overall and determining what aspect of the data each theme captured. Braun and Clarke (2006) suggested that it is at this stage that various themes are scrutinised to identify the story that each of them tells. This stage can be termed as a further refining stage. As part of the refinement process, the researcher had to examine how each theme fitted into each other and to the broader overall aim of the study and how the data in them explained the broader question of the study. This was done to ensure that there was not too much overlap between themes. As an example, in this sub-section four major themes were evident and they included:

1. Stakeholders’ understanding about quality SE in JSS;
2. Desirable features for quality science SE in JSS;
3. Factors limiting the provision of quality SE in JSS;
4. Promising strategies for improving the provision of quality of SE in Tanzanian JSS.

These phrases were the product of the whole process of making sure that the themes were concise, coherent, logical, non-repetitive, interesting, focused, and able to provide the reader with a direct sense of what each theme was all about.

6.13.3.6 Stage six

This is a report write-up stage, which involved more than just talking about what the data revealed – in addition, it involved making arguments in relation to the research questions. Creswell (2003) and White, Woodfield and Ritchie (2003) relates this stage of data interpretation to making meaning, or drawing sensitive

implications out of data. This stage could be related to the discussion of the findings of this study, which is articulated in Chapters 10 and 11

While working to make sure that the complexity of themes was preserved by using vivid examples such as direct quotes, the researcher used multimodal data analysis informed by the embedded design of mixed methods approach. This type of analysis was based on three areas of logic: the *rhetoric logic* in which the quantitative data set was treated to supplement the qualitative data set; the *multidimensional logic* which involved viewing and understanding data in more than one ways (thinking of data outside the box) and; the *corroborative logic* in which both qualitative and quantitative data sets were triangulated to explain how best SE could be improved in Tanzanian JSS. The analysis in this study was organised in a way that there was no separate section or chapters devoted to discussing separate views from a particular category of respondents. Instead, each chapter or section was dedicated to discuss the emerging themes, and information from individual respondents was referred to throughout each chapter or section. While understanding that this format was relevant for this study, the summary information about individual respondents is presented in a brief and clear description, along with discussion of the main themes at the ending of every main theme.

6.14 Ethical Issues and Considerations

According to Patton (2002) and Rubin and Rubin (2005) it is necessary to secure all necessary permission to conduct the study without causing harm to the prospective respondents. Since this study is education research, it required a researcher to adhere to particular ethical issues before undertaking the research. Adherence to ethical issues was intended to ensure that research respondents were not harmed during and after the research process or promulgation of results. This is supported King and Horrocks (2010) and Punch (2005) who insist on the idea that the study risks and harm to respondents need to be consciously avoided. These risks may include anxiety and distress to respondents, misrepresentation of respondents' ideas and the identification of the respondents in the final thesis (see Richards & Schwartz, 2002). As argued by Cho and Trent (2006) about the minimisation of danger to the respondents, this study observed all research conducts through the use of member checking, employing a pluralistic view within the realms of pragmatic lens, and providing

transcripts to respondents to discuss emerging research ideas. Other ethical practices evident in the research processes are discussed in the next subsections.

6.14.1 Access to the Respondents

Prior to accessing the respondents, the researcher had to obtain research clearance and an approval letter, which was issued by the Human Ethics and Research Committee at Victoria University of Wellington, which approved this study to be conducted in Tanzania (see Appendix S). At the research sites (Tanzania), a formal meeting took place with the involved Tanzanian Ministry of Education and Vocational Training (MoEVT) officials, specifically the Officer from the Department of Planning and Research, to seek approval and a letter of introduction to various Ministry departments and schools, and other selected respondents (see Appendix R). In completing the same application, a full research proposal, and evidence of ethical approval and/or supervisor's reference letter from the host, Victoria University of Wellington, was mandatory. The approval issued was intended to indicate that the Ministry was aware of the researcher's plans to visit the selected departments, and identified respondents for their consent to participate in the study.

The department offered an approval, and the introduction letter attached in Appendices P – Q show that the researcher was given permission to meet with the Regional Administrative Secretaries (RAS) whose administrative areas were involved in the study. The RAS introduced the researcher to the District Education Directors (DED), who in turn introduced the researcher to the District Education Officers (DEOs) whose districts were again involved in the study. Finally the DEOs introduced the researcher to the JSS. The respondents in each school were asked to willingly participate in the study, and they were assured that their decisions to either participate or not would in no way affect them. This technique was helpful in building rapport with respondents prior to their involvement in the study as most of them chose to participate willingly. At all times and at every level of respondent, the researcher introduced himself and explained what the research was about, as well as providing respondents with an assurance of a risk-free environment if they chose not to participate in the study.

6.14.2 Informed Consent

Before conducting any focus group, interview, or informal conversation the researcher explained to the respondents what the research concerned and asked for their permission for the discussion to be audio recorded. This was also the time at which both written and verbal consent forms were provided to all participants, depending on their literacy level (see Appendices H to G for consent forms). The respondents were required to sign them indicating their agreement or disagreement to participate in the study. The respondents were assured that they were free to discontinue involvement with the project at any stage without adverse consequences or penalty or loss of benefits to which the subjects were entitled. Silverman (2006) advises that while ensuring that relevant information about the research should be given to the respondents to enable them to make a decision on whether to participate in the research, it should also be ensured that participants understand the information given.

6.14.3 Confidentiality

All measures possible were taken to protect confidentiality of the participants. The respondents were assured of confidentiality by not disclosing their identities and/or indicating from whom the data were obtained. Although the reserve list of respondents was earmarked in case of discontinuation, no case of discontinuation was noted among the first selected participants. The respondents were also assured of not being subjected to pressure or inducement of any kind to encourage them to participate in the study. Otherwise, stationery vouchers were given to both teachers (during post FGD) and parents at the end of the data collection period in gratitude for participating in the study.

Apart from adhering to global ethical aspects in research, and institutional research principles around informed consent, the study was also framed within specific cultural perspectives, because studies have shown that it is not always possible to apply 'universal' ethical principles to research that can easily and smoothly operate at all spheres without conflicting cultural values. Omoke (2011) cemented this fact by arguing that the ethical research principles and considerations that are designed by universities and organisations in western countries cannot be applied to non-western countries, including Tanzania, without modifications, as they are prone to becoming meaningless in contexts

for which they were not explicitly designed. Similar to the contention by Omoke (2011), Ryen (2004) argued that the general ethical correctness of informed consent, irrespective of the location of the field, may be questionable with reference to research sites situated in non-western cultures.

The researcher shared the summary of transcripts and collected information with each participant for further verification, clarification and feedback when it was needed. The researcher conducted member-checking in which each participant was given a summary copy of their interview transcript or response sheet to assess whether or not what was transcribed was what they meant. At this point, the respondents had the right to alter, delete, or add any information to the transcript or notes regarding improving the quality of SE in schools. At this stage a problem amongst respondents occurred in which some participants seemed to hold a sense of unease that the researcher did not trust the information they gave him in the first instance. This is connected to cultural values among respondents, in which the processes of member checking and debriefing hold an implication of mistrust.

Assuring confidentiality and anonymity can be a very challenging task at times, especially for some research settings and respondents with unique characteristics that make them easily identifiable. This is because some research settings may have specific features that are easily recognised when the researcher describes the settings of the study and the profiles of the research participants (Mtika, 2008; Meena, 2009). Given such a fact, in this study efforts were made to ensure that the presentation of the findings does not reveal specific features for readers to identify. Further, the findings relate neither the specific research setting nor respondents with the statements or quotes included in the report.

For the purpose of maintaining the dignity and welfare of all participants, and for confidentiality reasons, pseudonyms were used for research sites, schools and all participants in the research. All identifiable information was removed and the participants were assured that everything possible would be done to ensure that information was kept confidential. The participants were availed of contact information from those were involved with the study, in this case, the principal researcher and the primary supervisor. The feedback was also promised to be

provided to the participants in the form of a summary sheet of main findings to those who requested it. Upon acceptance of this thesis, a link to the Victoria thesis on the VUW website will be provided to those respondents who indicated their interest in the final write up.

6.15 Summary

This chapter discussed the research methodology of the study. While situating a pragmatic stance in mixed methodology as a strategy of inquiry, the chapter described the study's general research plan, the paradigm underpinning the study, the study's research method and design, the researcher's positionality, research tools, methods of recruitment, validity and credibility and discussion of the ethical issues in this thesis. The chapter also indicated how the methodology used was suited for this thesis. The next chapter presents the findings: stakeholder's views about quality science education, its desirable features, its limiting factors, and the strategies that seem viable in overcoming the challenges to ensuring quality SE in Tanzanian JSSs.

CHAPTER SEVEN: FINDINGS I

STAKEHOLDERS' UNDERSTANDING ABOUT QUALITY SCIENCE EDUCATION AND ITS DESIRABLE FEATURES

7.0 Introduction

This chapter presents the research findings across the categories of respondents and research sites. The chapter reports the triangulated data from the analysed documents, questionnaires, focus group discussion, and interviews. The chapter also presents the stakeholders 'conceptions about quality science education' (SE) and its desirable features. The chapter identifies the stakeholders' understandings about what quality SE is and how should it look in JSS. The subsections that follow present the stakeholders views regarding these questions. In reporting the findings, the following abbreviations are used for the respondents (see Table 9).

Table 9: *Respondents' abbreviations*

Abbreviations	Meaning
DE	District Education Officer
ST	Science teacher
PA	Parent
S	Student
SA	Science alumni
HM	Head master/Mistress
CD	Curriculum development officer
SI	School inspectorate Officer
EC	National examination councils' officer
EA	National Education authority officer
ST	Officer from science and technology commission

7.1 The Stakeholders' Understanding about Quality SE

The findings showed that there were diverse understandings regarding quality SE in Tanzanian JSS. Table 10 summarises the questionnaire responses completed by all respondents, except students. The students' views were obtained through focus group discussion, and they are integrated in the discussion of sub-themes that follow after Table 10.

Table 10. *Summary of respondents' views on how they understood quality SE (N=43)*

C/N	SITES A, B			
	Quality science education was defined in terms of the following aspects:	Responses in %		
		Agree	Not sure	Disagree
1	Meeting stakeholders expectations	62	28.1	9.9
2	Development of students' potentials	88.9	2.7	8.4
3	Providing quality school experiences for students	85.1	9.3	5.6
4	Provision of good learning support services	86.7	7.6	5.7
5	Determinant of the learners' future life	62.2	6.7	8.9
6	Achievement of good grades in the final examinations	63.3	8.9	27.8
7	Development of survival skills among learners	73.3	17.8	8.9

Following the questionnaire responses are the combined respondent views from interviews, questionnaires, and focus group discussions regarding respondents' understanding about quality SE in JSS. The discussion that follows is guided by the subthemes presented in Table 10.

7.1.1 Meeting the Stakeholders' Expectations

The respondents described quality SE in terms of its ability to meet the stakeholders' expectation. This included meeting the stakeholders needs, contextual challenges and providing good educational achievements for the graduates. More than 60% of respondents were in agreement with the idea that quality SE had to be judged in terms of its ability to meet stakeholders' expectations. During an interview, one respondent said:

My understanding about quality SE goes beyond its ability to enable the learner to be able to read and write but rather its ability to respond to the stakeholders' [beneficiaries] preferences, desires and interests, as well as responding to the contextual challenges. (SA. 6)

The stakeholders' expectations towards SE were identified as revolving around social, physical and financial change among learners. One officer emphasised that, *"it is a desire of our nation through the educational system to develop its learners into useful individuals, and instil skills and knowledge among learners to enable them solve the society challenges"* (ST).

Students described quality SE in terms of having an expectation of competent teachers who would help them to get the best possible results, so that after graduation they would be in the best possible position to gain employment. Supporting this point one student pointed out that:

Quality SE is something that can be felt. It is about satisfying our fulfilment in terms of teachers' competences, having good educational outcomes and being guaranteed better achievements after graduation. I think it's about going through the school experience knowing that everything that will be harvested from it is of top class. (S 1)

The majority of respondents furthermore described quality SE as one that produces value-added outcomes for graduates. The respondents emphasised that quality SE was not just about acquiring good certificates, but rather about producing well-rounded individuals who could achieve at the highest possible level in society. Adding to this claim, one respondent noted that;

Quality SE does not only signify the high standard education and the best life that our wonderful science education system is able to deliver, it also relates to the availability of solutions for all contextual challenges. (HM 1)

Generally, the respondents identified two major expectations regarding quality SE. Firstly, quality SE was seen as a tool for providing a broad and balanced education; one that could answer most of the stakeholders' needs and meet their preferences, interests, and expectations. Secondly, quality SE was expected to produce competent science graduates able to contribute to the society.

7.1.2 Development of the Students' Potentials

Quality SE was described by most respondents (more than 80%) as being related to the development of students' potential, which in this context included educational excellence, acquisition of the necessary societal values, attitudes, knowledge, skills, and dispositions necessary for them to be functional members of their society. In the interviews, it appeared that most respondents believed no education system could be of high quality unless it helped in the development of those vital attributes among graduates, which would ultimately help them to face present challenges and take advantage of future opportunities. Students related quality SE to a holistic development of learners who were able to deal with the different tasks they would face in their future

lives, and who were enabled to participate in economic, cultural, and political life in general.

Science alumni agreed with the holistic development suggested by the students, but focused more on individual students' intellectual development. The continuing demand for developing quality attributes in students is reflected in the following quotation:

Quality SE is the one that emphasises the development of important learning domains in learner including: ethical, intellectual, physical, social and aesthetic development ... In other words quality SE needs to be the one that leads to the intellectual development of a whole learner and the one that competent, caring, critical, responsible and active members and lovable people in the society. (SA 1)

In a similar line of view the policy makers expected quality science education to produce knowledgeable and skilful graduates who were able to face challenges, were creative and versatile, could solve problems and had high moral values.

The respondents did not see quality SE as simply allowing students to attend school, or merely gaining the knowledge, skills and attitudes necessary for their futures, but rather, they saw quality SE as providing opportunities for personal development and confidence building, enabling learners to adapt to new situations as well as reacting to a variety of situations.

7.1.3 Providing Quality School Experiences for Students

Quality SE was described by over 80% of the stakeholders as quality school experiences including what students learnt at school, how they learnt, and what benefits students drew from their education. In the interviews, respondents related quality SE to being able to provide learning experiences that lead to academic gain in science subjects, as well as attitudinal and value change amongst students.

The articulation of the respondent's perspectives in this area can be highlighted by the following quote:

I would relate quality education to the high standard school experiences that students experience while at school including academic gains, attitudinal improvement, psychological stability, and development of all positive learner attributes ... Quality education is all about coming out with a level of knowledge and skills on subjects of specialisations rather than mere certificates at the end of schooling. (EA. 1)

The respondents appeared to share the view that quality SE experience should provide a sense of fulfilment among learners, and the satisfaction that they had received a quality educational experience from their schooling. Most respondents said it was not just about students achieving their potential but also about the school providing rich learning experiences. The purpose, in their view, was not to alienate students from society but to develop new perspectives on life through their school experiences.

7.1.4 Provision of Good Learning Support Services

The respondents described quality SE in terms of the availability and adequacy of students' learning support services. Examples of learning support services include weekly study skills workshops, study groups, homework help sessions for selected courses, after school academic teaching, accommodation support for students with disabilities, and the availability of study skills consultation. Table 10 shows that more than 80% of the respondents mentioned learning support services as important features for developing quality SE in schools. One educator added:

Quality SE is an outcome of the ability of the schools to provide sufficient student support services (well-equipped and up-to-date libraries and laboratories) to facilitate student learning but also it is still up to the students themselves to take the opportunities to improve themselves. (DE.

1)

During the interviews, most educators related quality SE to the quality of guidance and counselling services that enabled students to make informed decisions about future science careers. One teacher said:

Looking on what is happening in schools today ... students' choices are terrible and unguided, the choice in science is left to common sense, a situation which is not favoured by the status of it in schools ... I personally think there is a need to revive the guidance and counselling units in schools to strengthen students choices in science careers. (ST 2)

In view of the general responses concerning this subtheme, two issues seem common. Firstly, that quality SE is a function of well-equipped and up-to-date learning facilities, such as libraries and laboratories. Secondly, quality SE requires the availability of all necessary support services, and a school should provide students with counselling and career guidance as part of ensuring this

quality. Students also wanted after school support for learning and developing study habits.

7.1.5 Determinant of the Learners' Future Life

Quality SE was identified by over 70% of respondents as being a determinant of students' future lives. Respondents identified positive futures for students as including: a good life after graduation; gaining employment in science fields; being responsible citizens; attaining high social status; fulfilling the career dreams; and gaining material wealth. Most respondents described quality SE as an important component in improving students' ability to explore the opportunities for being successful, responsible citizens in their futures. Similarly, responding parents and science alumni described quality SE as being an important factor in not only shaping learners' futures, but also in enabling learners to gain knowledge that would help them have good future life, or gain employment in science related fields. They explained quality SE in terms of what students gained as a result of attending school. For example, one respondent said:

Quality SE plays a great role as a determinant of future career achievements and employment in science related sectors ... one in which the graduates (our children) can practically demonstrate what they have learned, can use that knowledge to solve the community problems and have a good job. (PA.1)

Most respondents during the interviews appeared to think that it was the schools' responsibility to help students make the right decisions, have the required knowledge and skills, and make the desired choices for future careers in science. Parents and science alumni were concerned that at present science education did not enable students to fulfil their career related dreams, arguing that quality SE ought to support students to become experts in their chosen scientific fields. The respondents also identified that socio-economic promotion was one of the components of quality SE. Quality SE should help individuals to attain a higher social status in life. The following quotation puts forth a science alumni's view:

Quality SE does not only mean acquisition of bookish science knowledge and providing good jobs in employment market, rather it is the increase of the learners' achievement in terms of economic status or increased chances for a good life in the future. (SA. 4)

Similarly, one parent said:

The vision I have is that my child is provided with quality education which would ultimately help my child to get a nice job at the end of it ... By the way who would send his/her children to a school if at the end of it they become useless, dependent and irresponsible? (PA.1)

The respondents appeared to share a view that quality SE meant nothing unless it led to economic gains among graduates, turned the graduates into successful employees, and enabled the graduates to meet their desires and expectations in order to have better future prospects.

7.1.6 Achievement of Good Grades in the Final Examinations

The respondents described quality SE in terms of students' achievements in the national examinations. For more than 60% of respondents, especially parents, quality SE was about gaining good grades in their final exams. They attributed the achievement of high exam grades to a better education system in their schools. One parent held the following view:

How can you say there is good education to our kids when there are a lot of failures every year in the final national examinations? ... For me doing better in the final examination for my kids has a close relationship to the quality of education offered in the school ... it is obvious that good grades come from quality education which ultimately produces the best students. (PA. 5)

Most respondents appeared to believe that quality SE was reflected in high examination achievement. Some argued that the achievement of good grades in the national examinations has a lot of implications on the credibility of the academic certificates, the standard of education offered, the competitiveness of the graduates to secure good jobs, and the mental capability of the individual graduate.

7.1.7 The Development of Survival Skills among Learners

Quality SE was also described by the respondents (70%) in terms of its ability to develop various survival skills, which include: expertise in science subjects, confidence, and problem solving skills, the determination to do well, and having the will power to make informed decisions. With respect to the challenges that most of Tanzanian JSS were facing, the respondents argued:

We need to have an education system that builds confidence in us for our future life. A system that would go beyond preparing us for other levels of education but one that trains us how to survive and make our life meaningful using the learnt knowledge obtained during schooling time. We need to be productive and successful people after our studies but I am sorry to say that the system is not there yet. (S.6)

It was argued that quality SE should enable students through developing sound survival skills, something which respondents felt was lacking at present. Respondents seemed to value preparedness and the ability of their children to have decent lives after graduation. It appeared that what the future would hold for their children in science was not clear to most parents, and this was a matter of concern.

In expression of their desire for quality SE in schools, most respondents wanted the SE system to possess several ideal features, which are discussed in the section that follows.

7.2 The Desirable Features for Quality SE in Secondary Schools

In the quest for what would be the desirable features of quality SE, the respondents seemed to have varied views. Many of the features mentioned were not definitive but were useful starting points for further discussion. Table 11 summarises the questionnaire responses from all respondents regarding the desirable features for quality SE. Students' views are not included in this table, as they were not asked to respond to the questionnaire. Rather, as noted, student opinion was obtained through focus group discussion.

Table 11: *The desirable features for quality SE identified by respondents (N=43).*

C/N	SITES A & B			
	Desirable features for quality science education in Tanzanian junior secondary schools	Responses in %		
		Agree	Not sure	Disagree
1	Presence of effective educational policies	91.1	0	8.9
2	Presence of sufficient teaching and learning resources	88.9	4	7.1
3	Presence of good attributes among science teachers	88.9	0	11.1
4	Presence of good collaboration among stakeholders	80.4	16.9	2.7
5	Presence of active teacher development programmes in science	88.9	0	11.1
6	Presence of good leadership attributes in education	71.1	11.1	17.8
7	Presence of supportive learning environment	80	8.9	11.1

Following the questionnaire responses, are the triangulated respondents' views from interviews, questionnaires and focus group discussions regarding the desirable features of quality SE.

7.2.1 Presence of Effective Educational Policies

Effective educational policies were described by more than 90% of respondents as being one of the desirable features for quality SE. The effectiveness of educational policy was identified by respondents as including the following attributes: good alignment of the policy with stakeholders' educational targets, context responsiveness of policy, clarity and attainability of aims, goals, and missions, and the vision of the policy. The respondents appeared to share a view that the vision of education policy needed to be developed from the common beliefs and values of society. Most respondents believed that doing so would help in harmonising the different interests of all involved in provision of quality SE.

Data from the interview showed that generally the respondents believed that the current Tanzanian education policy of 1995 was poorly planned, and its goals and targets had not been realised in the past seventeen years. Some believed that this was because the policy was unrealistic and regulated by political motives. Such policy ineffectiveness was identified by most respondents as the

reason for the failure of the policy to address Tanzanian contextual challenges. Some respondents, such as science alumni, identified a need to start questioning the authenticity of educational policy as to why its targets have not been successfully achieved:

In my view most of us have lost hope for achieving the promises of the policy of education in practice. We had a lot of expectations from Education and Training Policy (ETP) all of which have not been achieved. To be honest ETP has not produced any significant changes in schools. In fact we are wondering where the good promises of ETP have gone? I think there is a need to continuously question the policy with effective reviews which would ultimately identify the successes and failures of the policy, information which is likely to be helpful for future improvement of the policy. (SA 5).

Most respondents attributed the failure of the policy to address the Tanzanian context to poor planning and poor administration of the policies, as well as poor structural reforms shaping educational practices in Tanzania. Some respondents thought that inadequate policy review and monitoring processes were also affecting the development of quality SE. Responding policy makers also complained about an increasing number of structural reforms and sector policies which in their view had little impact on the education sector. Examples of a number of such cited policies and structural reforms are presented in Table 12.

Table 12: *Policies and structural reforms shaping educational practices in Tanzania*

Category of the Policy & structural reform	Name of the policy/ structural reform
Policies and structural reforms governing the education practices	Policy of Education for Self-Reliance introduced in 1967 to guide the planning and practice of education.
	Universal Primary Education (UPE) and the Musoma Resolution in 1974.
	Tanzania Development Vision by 2025.
	Education and Training Policy (1995).
	The National Strategy for Growth and Reduction of Poverty (NSGRP/MKUKUTA).
	The Education Sector Development Programme (1996).
	The National Technical Education and Training Policy (1996).
Supporting policies and structural reforms	Vocational Education and Training Act (1994).
	Institutional Vision focused on implementing Vision 2025 aspirations.
	International Quality Standard and Capacity building.
	The National Science and Technology Policy-1995 (Reviewed 1996).

The educators, science alumni and Heads of schools raised their concerns about the efficiency and impact of these policy and structural reforms in developing quality SE. Concern was raised about the number of reforms and the need for complex monitoring and evaluation frameworks to produce change for better educational outcomes. Some suggested there was a need for a centrally controlled and mandated authority to monitor the programme's effectiveness.

During the interview, a large number of respondents argued that the current evaluative processes to ascertain the effectiveness of policy implementation in practice were inefficient and ineffective. They suggested that this was contributing to a lowering of standards and was impacting the quality of education at all levels of education in Tanzania. One respondent commented that:

Looking at the current situation of education in our schools, I fail to believe that no one cares about what is going on in the education sector as far as provision of quality SE is concerned ... The policy has changed twice, but with unproductive expected outcomes. I am really suspicious of how the policy efficiency is being evaluated. Because if it was okay, I would expect to see positive changes in schools learning experiences, including the success of answering both the stakeholders' expectation and the contextual challenges. (SA 5)

Several educators were frustrated and shared the view that the educational goals set were unrealistic, that the knowledge and skills taught were of little use to the learners. The notion of the need for learners to fit well within society was also reiterated.

7.2.2 Presence of Sufficient Teaching and Learning Resources

The availability of teaching and learning resources was identified by almost 90% of respondents as being a desirable feature for quality SE. Cited teaching and learning resources included the availability of sufficient, up-to-date and relevant science textbooks (students' books and teacher guides), the presence of qualified, competent, caring and motivated teachers and educational managers, and the availability of teaching and learning aids (textual, visual and audio-visual materials). Figure 8 summarises respondents' views from the interview regarding the adequacy of teaching and learning materials.

**Figure 8: Adequacy of Teaching and learning materials
(N=65)**

Most respondents also shared the view that for quality SE in schools to be possible, context specific human resources, such as support staff, were required. One participating teacher noted that:

It is not possible to attain our desire to provide quality SE in all JSS if there is no special consideration about the provision of adequate teaching and learning materials, not to mention the visual and audio, textual and non-textual ones ... in fact the major hurdle that schools struggle to solve in today's schools is the resource related challenge.(ST.3)

Data from the interview showed that most respondents believed that it was not enough to have sufficient teaching and learning resources; the effective use of such resources was just as important for developing students' academic and professional competencies. While educators noted that they had heavy workload issues and insufficient teaching and learning resources, the science alumni appeared to blame educators for not being improvisational and creative enough to provide quality SE in spite of a shortage of resources in schools.

7.2.3 Presence of Good Teachers' Attributes

More than 80% of respondents shared the view that good teacher attributes were among the desirable features for quality SE. Good teacher attributes were described as including: being well trained, having appropriate subject matter knowledge, having the motivation to teach, and being experienced. Most respondents (see Table 11) highlighted the importance of teachers' attributes in providing quality SE in JSS. Respondents felt that quality SE was only possible if teachers were kind, wanted to teach, were patient, caring, and friendly, passionate about teaching, committed to the profession, resilient, and felt

deeply about being responsible for their students' learning. One Head of school mentioned the following:

I think there is a close relationship between quality SE and the quality of teachers with respect to students' learning experience ... I also think that teachers' competences can overrule all factors influencing the provision of quality SE ...in my view there can be no quality SE unless teachers possess all vital teaching skills and have the morale to make changes in students learning. (HM)

In the same vein another educator said:

Teachers are the key for a quality SE system ... in my view if I had the power to change the situation of the current SE I think I would first start with making sure that all teachers possess requisite skills, knowledge, attitude, and other dispositions necessary for them to provide best learning experiences...of course this goes in tandem with redefining the teaching beyond what teachers do in the classroom to the process of influencing individual learners to be useful to their society. (ST.2)

Despite its necessity in SE, teaching in Tanzanian JSS was described by most of the respondents as an undervalued profession. Further, a majority of respondents believed that the poor perception towards the teaching profession was negatively influencing the efforts towards the provision of quality SE. One education officer said:

It is true that teaching is rarely the first choice for any teacher in our country today. The fact is that all these teachers you see in schools today are those ones who were dreaming of being engineers, medical doctors and when their ambitions failed they moved to the next option which is teaching ... in fact I can confidently tell that being a science teacher in Tanzania is often an accident. (HM)

Most respondents shared the belief that teacher related challenges were the most significant barrier to realising the vision of providing quality SE in Tanzanian JSS.

7.2.4 Presence of Good Collaboration among Stakeholders

Quality SE was described by more than 60% of respondents as being dependent on the presence of good collaboration among the SE stakeholders. Such collaboration amongst the stakeholders would include teamwork, strong accountability, information sharing and good communication, positive professional relationships, and the willingness to participate in and contribute to educational matters. One education officer said:

Without good relationships among the educational departments and among us, the delivery of quality SE is impossible. See what is happening today in our education system ... the issue of accountability in education is quite an unshared responsibility ... it is even not clear who is responsible for what! Such divided responsibility has a lot to tell why quality SE in schools has been a difficult goal to achieve. (CD)

During a follow-up interview, most Heads of schools shared the view that quality SE was possible only if it allowed the participation of everyone who could make a contribution. This would involve having a shared effort towards developing a quality SE system. One respondent reported that:

It is important to have a strong collaborative scheme in implementing our goals of education where each one of us has a special role to play. The non-inclusive practices that are experienced in Tanzanian JSS today will not lead us anywhere if surely our goal is to enable our children receive quality SE in schools. (SI)

Most respondents, except students, said that the provision of quality SE in Tanzanian JSS was possible if the MoEVT (the TIE, NECTA, TEA, and the school inspectorate departments), the partner ministries and stakeholders (such as parents, business people, school management, students, social service agencies, the community and colleges/universities) were valued partners who all had significant contributions to make in providing the best SE experiences in schools.

7.2.5 Active Teacher Professional Development Programmes

Well-planned and goal-oriented teacher professional development programmes were considered essential for providing quality SE. More than 85% of respondents said that it was important to ensure the existence of active teacher professional development programmes which would provide teachers with up-to-date knowledge and skills for them to be able to provide quality SE experiences to students. As such, the provision of seminars, conferences and workshops to improve pedagogical competencies in science teaching would be essential. A common belief amongst most respondents was that quality teacher professional development programmes were necessary, not only as requisite components for providing quality SE, but also for providing opportunities for teachers to be informed of recent developments in science, science education and new pedagogical approaches. One educational officer said:

An education system cannot be characterised and rated as an excellent one unless it has dependable teachers with strong academic knowledge, with the ability to use the school environment as a mini working world, with sufficient experiences and with all the features that indicate the availability of sufficient and strong knowledge base, the attributes which can possibly be acquired if there is active teacher professional development programmes. (SI)

While emphasising the need for a strong workforce in SE, the respondents stressed the need for significant capital investment in teachers. One respondent explained that:

For our education system to excel in SE there is a need to adequately train more teachers who will ultimately provide a means for enabling learners to become competent, versatile and independent in their major fields of study. This is to say investing in training individuals to become science teachers is a must if we really want students in JSS to receive quality SE experiences. (ST)

Data from the interviews also show that most respondents appeared to share the view that attracting qualified young people into the teaching profession, and retaining, supporting, supervising, and providing them with the necessary skills, were important prerequisites for providing quality SE in schools. Commitment to developing the SE workforce was described by most respondents as being important to the nation for three major reasons: providing competent teachers, producing competent graduates that met global demands, and helping the country to have adequate science experts and educators.

7.2.6 Presence of Good Leadership Attributes

Good educational leadership was described as a desirable feature of quality SE by most respondents. More than 71% of respondents shared the view that possession of relevant, competent leadership skills, and educational managers with the vision and desire for quality SE was a vital prerequisite for achieving the goal of building and maintaining the standards of SE in schools.

Most respondents were in agreement that achieving high quality SE was not an easy task, as it required inspirational, enthusiastic, and committed people to develop educational programmes that can provide learning with superior academic experiences. While science alumni focused on the need to have responsible leaders who wanted change in the way SE was delivered in schools, teachers considered strong educational leadership and management a

solution for the success of SE. The teachers argued that failure of most Heads of schools to support school based science programmes was a barrier to quality SE. One respondent added that:

If we need quality SE in our schools we need well-qualified and experienced educational leaders who are able to set expectations for teachers and our children ... with a sound, up-to-date knowledge of how the children should learn and develop ... with the ability to translate knowledge into coherent expectations for teaching, and on-going reflection on practice of quality SE in our JSS. I would want to see the type of leaders who are able to trust and empower educators, children and families towards developing quality education. (PA.1)

Effective leadership that would manage learners' knowledge development and ensure learning objectives in science were met was considered important by most respondents. Some considered effective school management and administrative leadership as necessary aspects in nurturing the instructional programmes and school culture.

7.2.7 Presence of Supportive Learning Environment

Good and supportive learning environment was described by 80% of respondents as being a desirable feature for quality SE. A supportive and productive learning environment was referred to including the physical learning environment (manageable class sizes that support collaborative learning), an intellectual learning environment that stimulates students to think, and an emotional learning environment where students are safe, supported, respected, disciplined and motivated to learn. One respondent said that:

Just as one needs water, air, food and shelter to survive; the schools also need to possess several attributes for them to provide quality SE. I would love to see schools being the places where everybody feels happy being there, free from political interference, I mean free limitations to smooth learning...I am getting sick of the emerging situation whereby schools are being turned into certificate shops, and political arenas, the practices which have made schools abandon the vital role of promoting learning and acquisition of skills among learners (SA 6).

Parents, teachers, and science alumni commonly held the view that quality SE in JSS requires a highly supportive learning environment where students felt comfortable, connected with their learning process and their instruction personalised. Most of respondents appeared to share the idea that quality SE was possible with an existence of a learning environment that allows students to

take responsibility for their own learning, take risks and express themselves. Several respondents believed having a learning environment which minimised physical, social, cultural, and political barriers would be conducive to students' science learning.

7.3 Summary

Overall, the questionnaire and interview data showed that most respondents considered it important that quality SE achieved the stakeholders' expectations of a balanced education system [that meets the stakeholders' interests and preferences]. They believed that it should lead to the holistic development of all students. Quality SE should provide useful learning experiences that lead to knowledge and skill development for future needs. They argued for the availability and access to learning support services, including guidance and counselling for making informed subject and career decisions. They considered that such education ought to support students for a better life in future in terms of employment.

Achieving good grades in examinations was a priority for parents and students. Most stakeholders expected quality SE to develop survival skills amongst learners too. In all interviews the underlying idea about quality SE working to help students to make a contribution to society and nation came through strongly. Most respondents shared the idea that quality SE was likely to be provided in schools that had sound educational policies and where the values and beliefs of all SE stakeholders were taken into account. Availability of quality teaching and learning resources was considered important.

There was also an agreement amongst most stakeholders that employment of knowledgeable, skilled teachers who chose the profession, were passionate about teaching and learning, and cared about the children was essential. Most respondents wanted teaching to become a valued profession that attracted capable people, who would be provided with on-going professional development to keep abreast with new developments in their subject fields and in education generally.

Respondents believed that educational leaders with vision and good management skills who collaborated with parents and teachers to provide a supportive and inclusive learning environment were the key to quality SE.

Having noticed a strong awareness of having quality SE as important factor for Tanzanian future as articulated by respondents in this chapter; the next chapter presents respondents' views regarding the limiting factors and perceived solutions for providing quality SE in Tanzanian JSS.

CHAPTER EIGHT: FINDINGS II

STAKEHOLDERS VIEWS REGARDING THE LIMITING FACTORS FOR PROVIDING QUALITY SE AND THE UNDERLYING STRATEGIES TO OVERCOME THEM

8.0 Introduction

This chapter presents the stakeholders' views on the issues influencing quality SE and the strategies needed to overcome them. The respondents' view these issues as emanating from several circumstances including the learner, the school as a learning institution, the education system and the broader cultural, economic, social and political contexts. Data from different sources such as interviews, questionnaires, document analysis and focus group discussions were triangulated to identify the limiting factors influencing the provision of quality SE in schools. In this chapter the respondents are identified using several abbreviations (see Table 9). The chapter focuses on answering two major questions: What are the limiting factors for providing quality SE in Tanzanian JSS, and how can these limiting factors best be addressed? The respondents' views regarding these questions are presented in the sections that follow.

8.1 Factors Influencing the Provision of Quality SE in Tanzanian JSS

In fulfilling the responsibility of an education system to provide and sustain quality SE in schools, data from the respondents revealed that the current system is faced with a number of limiting factors which appear to have a negative influence on providing quality SE experiences. Such limiting factors seemed to be rooted in the way SE is planned, practiced, evaluated and monitored. Table 13 summarises the respondents' questionnaire responses regarding the factors that were described as influencing the provision of quality SE. These questionnaires were provided to all respondents except students whose views were obtained through focus group discussion.

Table 13. *Summary of stakeholders' questionnaire responses on issues and challenges in the current SE system (N=43).*

C/N	SITES A, B			
	Factors limiting the provision of quality SE in Tanzanian junior secondary schools	Responses (%)		
		Agree	Not Sure	Disagree
1	Inadequate community support	74.4	5.6	20
2	Lack of government support	95.1	3.7	1.2
3	Lack of infrastructural facilities in schools	69.3	27.2	3.5
4	Insufficient teaching and learning resources	90	6.5	3.5
5	Ineffective strategy of decentralisation in education sector	62.2	28.9	8.9
6	Ineffective integration of ICT in education	92.2	2.5	5.3
7	Inadequate students' commitment, readiness and interests in learning	71.1	8.9	20
8	Ineffective teacher attributes and their working conditions	100	0	0
9	Ineffective policy of education	80	20	0
10	Curricular irrelevance	89.9	9.1	1
11	Poor command of English for both teachers and students	64.4	11.1	24.5
12	Inadequate pedagogical approaches among teachers	91.1	0	8.9
13	Irrelevance of science content in science text books	81.1	10	8.9
14	Ineffective strategy towards provision of quality SE	62.2	28.9	8.9
15	Poor assessment procedures in education	91.1	0	8.9
16	Ineffective link between theory and practice of science	93.3	1.1	5.6

Following the questionnaire responses, are the interview and focus group discussion responses regarding the limiting factors for quality SE. In the subsections that follow, the responses from all data sources are merged to explain emerging sub sections:

8.1.1 Inadequate Community Support

Community support was identified by most (74%) respondents as an important component for providing quality SE in schools. Table 13 shows that conversely more than 20% of respondents, most of which were parents, were not in agreement that community involvement in providing SE in schools was necessary. Parents appeared to know little about their role in their children's

education. Such ignorance was the reason behind their lack of understanding of their role in supporting the efforts to provide quality SE in JSS. As one parent said:

Why should I participate in school matters when teachers are there? After all I don't know anything about what goes on in the schools, apart from knowing that my child must be educated ... and that is what we are paying for. (PA.6)

Similarly, another respondent had the following to say:

How can the community be active in educational matters when most of us did not go school, we barely know how to read and write ... so how can our participation be of value? (PA.5)

The science alumni on the other hand shared the view that there was a huge gap between schools and the community in matters relating to the schools' daily processes; a situation credited with weakening the partnership and teamwork spirit in providing quality SE in schools. A shared view among most respondents was the idea that the absence of good partnerships was not only common at school-community levels, but even at national levels. One respondent revealed that:

I think there is a lack of trust among all education stakeholders. I am confident to say that the relationship is very bad. Neither us nor the community have been shown to be important and necessary in developing a strong SE education system ... I am not surprised to see the community is holding back to support the school initiatives for quality SE because they had been paralysed and made as never existing in matters relating to education apart from pursuing them to pay the school fees for their children. (SI)

Data from the interviews generally showed that there was a problem of disconnectedness between stakeholder groups. Examples of these partnership gaps include an absence of good partnership between the MoEVT's departments, and between schools and the community, all of which were considered essential in providing quality SE in schools. Most respondents considered a need for strong partnerships among SE stakeholders, education partners, government and non-governmental organisations and society at large to collectively act together with a common goal to ensure that learners in schools received excellent SE experiences.

8.1.2 Lack of Government Support

The success in providing quality SE was described by more than 90% of respondents as having a close relationship with the availability of the government support. Government support in this context includes an indication of strong will and commitment to support SE programmes in terms of funding and providing the material and human resources that are necessary for learning. Most of respondents shared the view that the government was very reluctant in issues concerning the development of SE, a situation exemplified by inadequate, unreliable and insufficient funding to develop SE. One respondent added that *“we are sometimes obstructed by the government political unwillingness to support SE related programmes, a situation which in fact influences the efforts to meet the goals of providing quality SE in schools”*(CD). Most respondents appeared to share the view that it was the responsibility of the government to make sure that the policies in place supported the provision of quality SE in JSS. One regional MoEVT representative said:

We acknowledge that every person in this country is entitled to good education, SE in particular. We cannot deny our people to achieve quality education because without it even our development ambitions are useless ... but as important stakeholders we are all duty-bound to find solutions to various issues, problems and challenges of education by ensuring that quality education is provided to our students. (DE.1)

The consistent view among most respondents was the idea that there was a sense of negligence, reluctance and poor commitment by the government towards developing quality SE in schools. Support from the government, specifically on supporting the initiatives to provide quality SE in schools, was considered by the respondents as poorly prioritised, a situation which they described as limiting the nation in bright futures in SE. Respondents blamed the government for its small allocations to SE as compared to other educational sectors, feeling that the government ignored the fact that SE is a capital intensive discipline. The majority of respondents appeared to share the view that the government's unsupportive practice towards quality SE not only contradicted the country's commitment to train twenty first century scientists, but also crushed students' dreams in pursuing science related subjects as their future careers.

8.1.3 Lack of Infrastructural Facilities in Schools

The majority of respondents (60%) related quality SE to the availability of infrastructural facilities in schools including the adequacy of classrooms, staff rooms, libraries, counselling and guidance units, first aid units and laboratories. Most respondents shared the view that the Tanzanian SE system was facing infrastructural problems such as inadequate classrooms, lack of staff rooms and lacked in first aid units, career counselling and guidance units and laboratories. Even where laboratories and other facilities were present they were usually not well equipped, with no attendants, no chemicals and obsolete equipment. Most respondents shared the view that infrastructural problems play a significant role in denying students a chance to acquire scientific skills and quality SE experiences; a situation also noted to be reducing learners' interests in science studies.

Most respondents, especially heads of schools and science alumni, blamed the government for its failure to subsidise private schools to be infrastructurally well supported. The other disheartening issue raised by the majority of respondents was the fact that most JSS, lacked classroom basics such as student tables and chairs, especially the ward secondary schools, consequently causing congestion of students in classrooms. One respondent said:

How can a student learn in conditions where no up to date library, no laboratory, no books and other necessary materials ... the classrooms that were built to accommodate twenty of us in those days, are the same that are used to accommodate 50-70 students in today's schools ... How do you expect learning to occur in such an environment? To me it is not surprising to see most students in today's schools complete the schooling period without knowledge and skills (HM)

The majority of respondents considered that it was important for the Tanzanian government to support the efforts towards quality SE. Most of them felt this initiative could occur in a number of ways, such as making sure that schools were well furnished with all necessary facilities and equipment, granting a funding boost to support all schools' efforts towards quality SE, and influencing the improvement of school learning experiences so that students were able to develop mentally, psychologically and affectively.

8.1.4 Insufficient Teaching and Learning Resources

Most respondents felt that quality SE also required the availability of teaching and learning resources. Such resources included visual, audio-visual, textual and non-textual materials. Almost all respondents shared the view that inadequacy in teaching and learning resources was one of the factors for poor quality of SE in schools. Most respondents identified the shortage of teaching and learning resources as playing a significant role in limiting learners to benefit from the range of science information available to them, a situation which is also identified as limiting the learners to pursue science using different sources of learning resources. One of the respondents said:

Most of us are not familiar with the variety of resources available for us to excel in our studies. This situation ultimately increases the chance for most of us to be more dependent on teachers who are usually not available for us. As a result this situation not only denies us a chance to interact with other ways to acquire knowledge in science but also limits us from excelling in science subjects. (S.5)

Most respondents appeared to agree with the idea that the government was to be blamed in a number of ways, such as not creating information sharing centres, not producing a variety of ways in which students could learn science, and not providing support learning materials for those students who wanted to learn science beyond what was learnt in the classrooms.

8.1.5 Ineffective Strategy of Decentralisation in the Education Sector

The respondents related the decentralisation process, which took place in the Tanzanian education system between 2005 and 2010 as one of the factors that contributed to the decline of quality SE in JSS. The majority of the respondents (see Table 13), especially science alumni and educators shared the view that although the aim of decentralisation in education had good intentions for fostering a greater degree of student and teacher motivation, parent participation, bringing a sense of school ownership, curriculum adaptation, and improving community contribution, the strategy shows some signs of failure.

One educator commented that:

The devolution and delegation strategies of decentralisation have resulted in reluctance, decline of accountability and poor collaboration between the departments within the MoEVT departments and between the MoEVT and other partner ministries. It is very obvious that the development of SE in the country has been turned to a no one owned business through decentralisation process. In general the strategy has failed to specify the demarcations of power and authority among the educational key players. (HM)

In a follow-up interview another respondent noted that;

The development of SE in our schools is currently so confusing, especially when it comes to assessing whose responsibility could that be. Is it a responsibility of the COSTECH under the Ministry of Science? Is it the MoEVT or the PMO-LRGAs? Is it a shared responsibility? If so, what are the roles of each ministry in this? But again which policy is to guide the SE in schools? Is it the ETP or the policy for science and technology? These questions were not clearly addressed in the decentralisation. (ST.2)

Data from the interviews showed that most respondents were in agreement on the idea that the decentralisation strategy needed to be redefined so that it would portray a balanced power-sharing between the centre setting policy and the periphery carrying out the implementation of the policy. But again the respondents considered the need for a detailed redefinition of power and authority in the education sector for the sake increasing accountability and efficiency.

8.1.6 Ineffective integration of Information and Communication Technology (ICT) in education

Quality SE was also related to the extent with which the education system has managed to integrate ICT in education. ICT integration in this context was described by respondents as involving the adequacy of technological equipment in schools, the availability of educational software, and an environment that supported the best use of teaching and learning techniques based on ICT. Despite few science teachers and science alumni showing an interest towards integration of ICT in science classes, More than 90% of other respondents raised concerns regarding the situation whereby most schools lacked teachers trained in ICT. On top of that respondents stressed the fact that few students

had an idea of using computers in learning. One respondent angrily vocalised the following:

How can the efforts to improve the use of technology in SE be successful in the country when still the telecommunication network is limited to the main cities and when the internet access is still too expensive? The cost of internet has made it most difficult for some schools and other educational institutions to access or afford the internet costs, hence hindering the efforts to improve science learning through ICT. (ST.8)

This opinion echoes the view of the majority of respondents who felt that the success towards deploying and using ICT effectively was limited by a number of challenges which included a lack of co-ordination of ICT in education activities within the MoEVT, limited numbers of teachers trained in ICT, limited skills for integration of ICT in education, ineffective strategies to integrate ICT in teaching and learning, and a lack of incentives and schemes of service for ICT trained personnel.

8.1.7 Inadequate Student Commitment, Readiness and Interests in Learning

The respondents related that the inadequate quality of SE was compounded by factors affecting students specifically, including insufficient student readiness, commitment, interests and will to learn, students' SE background knowledge, students' former SE experience during primary education, student competence in the language of instruction, student motivation, family pressure, student perseverance to endure the challenges of science subjects, and students' attitude towards science studies. As shown in Table 13, more than 70% of respondents were in agreement that inadequate student commitment, were a source of problems in achieving goals to provide quality SE in schools. Most of the respondents, except students, complained that students learning behaviours were responsible for hampering the efforts towards delivery of quality SE. While students were hesitant to speak about themselves, most respondents commonly viewed student behaviours in learning as a multi-faceted system, which required several aforementioned student internal characteristics positively operating.

One respondent had the following to say:

It does not bring a good feeling for me, to see that students are increasingly losing interest in science, either as a possible future career, or as an intrinsic interest that they would need to continue with after JSS education. In my view we cannot ignore the function of their internal and external characteristics which happen to shape their behaviours in learning. (ST.4)

Most respondents mentioned another critical factor: inadequate strategies for developing student's independent learning skills, a situation which was identified as leading to an increase of dependency on teachers for everything. As such, respondents considered the need to develop self-learning skills among learners because by doing so it would help in addressing a lot of challenges such as a shortage of reliable teachers in schools.

Data from interviews and focus group discussions consistently revealed that students were showing lukewarm attitudes towards science, with preferences to forgo science after secondary school education for other more lucrative subjects, or courses like accounting, political science, and law. Evidence from the teachers' questionnaire showed high percentages of agreement on student attitudes and characteristics as important factors able to influence the provision of quality SE. Looking at the findings in Table 14, it is clear from the teachers that 62.5% of students' responses revealed a love for science subjects, but found that the language of instruction, lack of science background knowledge, and insufficient exposure to science sources obstructed them from effectively learning.

Table 14. *Summary of teachers' responses regarding students' characteristics (N=16)*

Statement	Responses (%)		
	Agree	Neutral	Disagree
Students do not like science subjects	37.5	0	62.5
Students do not easily understand the subjects	43.8	25	31.2
The language of instruction is foreign to students, difficult to use and limits the mastery of the subjects with ease	93.7	0	6.3
Students are well-informed about science via different information sources available in school	12.5	0	87.5
Students have a well-grounded background knowledge in science	25	0	75

Most respondents also appeared to share the concern that it was not always those students that actually had an interest in science that chose to study it; some students study it by default after failing to achieve the grades that would qualify them to study more lucrative courses such as law, accounting, banking, finance and so on. The science teachers and science alumni shared the view that most students who select science in today's schools are probably those who do not have any ambition to continue with science as their future careers. One respondent added; *"I am not surprised to see some students who studied science in junior secondary schools dropping it for other subjects, which they believe are more lucrative than science"*(ST 12). A consistent view among the majority of respondents was the idea that the students' behaviours in learning needed more attention as they played a great role in determining the extent at which learners can engage, develop and persist in science studies or careers.

8.1.8 Poor Teachers' Attributes and their Working Conditions

Poor quality SE was identified by most respondents as being related to the lack of committed, qualified and experienced science teachers. More than 90% of respondents shared some concerns about an increasing shortage of well-trained, qualified, career-committed science teachers as well as increasing rates of absenteeism for both students and teachers, and the emerging poor teaching environment. Most respondents held the common view that teachers had a special role in science learning which, if not handled with care, could lead to an aversion towards science among learners.

The lack of personal and professional development by teachers was another factor most of respondents mentioned as inhibiting the teaching and learning of science. Figure 9 shows that for the whole year of 2012 (when this research was being conducted), most teachers interviewed revealed that they had not attended any teacher professional related development.

Figure 9 *professional developments among educators in the last 12 months*

Most respondents shared the sentiment that teachers had failed to develop themselves professionally due to lack of support and the unavailability of teacher development programmes. This problem was described by most respondents as contributing to the situation, whereby teachers were neither adequately informed about new discoveries in science, nor possessed of adequate skills in the latest methods, approaches and strategies for teaching and learning science. One respondent said:

In my view I think teachers really need to have frequent teacher professional development programmes. This reminds me of a situation whereby one teacher entered our Chemistry class and he was not aware of simple amendments of Daltons' Atomic Theory. This is so unbecoming...I think it is embarrassing our teachers and it is unfair to us. (S.8)

In an informal discussion with educators, some admitted they were neither able to apply context-based approaches in their science classrooms, nor possessed of thorough subject-matter knowledge to withstand the challenges of the current pedagogical shifts in SE. One respondent said that:

The government has made us dormant. It neither supports us to update our knowledge about new developments in our career nor cares about the efficiency of learning that we facilitate in the classrooms. Always the government has been full of excuses about the shortage of funds to support our professional developments. I ask myself how much does it cost to support in school teacher coaching, or peer teacher support? How much does it cost to have a single teachers day in a year for us to have an avenue where we can share our experiences. It is my hope that things will change if we really need to provide quality SE experiences to our students. (ST.1)

During the following discussion educators mentioned the situation whereby the country has been losing a significant number of qualified science teachers to countries like Botswana and Namibia, because teachers are paid much better salaries and live decent lifestyles through their teaching profession in those countries. One science teacher added that:

Like many science teachers in the country I have found myself battling to strike a balance between my burning passion to make an impact in the life of my students through science but the frustrating working conditions could not let me be ... I have endured a lot of discouraging situations since I started teaching this subject in this school. But I hear that stories are different for teachers in other countries such as Botswana. (ST.4)

The respondents also shared a concern that there was a sense of unfriendliness among teachers, a situation which was noted as influencing efforts to build a spirit of working together to develop quality SE in schools. While being proud of their colleagues from other professions, the educators considered there was a need to improve their working environment. One educator had the following to say:

To be honest our working condition is very demotivating. It is because of this situation that some defiant secondary school science teachers posted to most remote schools "fled" to other areas with better working environments, and others changed careers ... thus creating an appalling shortage of science teachers in most schools. If you ask me, the solution is just simple, improve the teachers' working environment and everything will be fine. (HM)

In the same vein, educators appeared to be concerned with the issue of teachers' remuneration being too low to the extent of not encouraging teachers to give their best. They felt some of the teachers were neither showing enough enthusiasm in their science classrooms, nor being committed to their teaching because they were poorly paid. The respondents happened to share the view that low payment among teachers not only affected teacher commitment to teach their science classrooms passionately but also forced most of them to opt for part-time employment or private business enterprises in addition to teaching in order to make ends meet. The reality of inadequate teacher salaries and allowances, the lack of motivation and opportunities for ongoing professional development were described by most respondents as contributing to the reduction of teacher morale and as affecting their attitude to teaching. Respondents consistently stated that it was important to take drastic measures

in addressing issues concerning the teaching profession and the teachers' working environment, because by doing so it was likely to significantly motivate and increase the morale of teachers in handling their classrooms with passion.

8.1.9 Ineffective Education Policy

Another problem for quality SE cited by respondents was policies that were unclear, too political, poorly focused, or non-attainable. The findings in Table 13 show that 80% of respondents shared the view that the Tanzania educational policy in practice was ineffective as it placed too much weight on the quantitative rather than qualitative aspects of education. They also noted that at present the Tanzanian education policy was celebrating the "*Bora Elimu*" slogan (*Just Education*), rather than "*Elimu Bora*" (*Quality Education*). Such a type of education was identified by most respondents as hampering the efforts towards providing quality SE in schools. One respondent said the following:

It is quite surprising to see policy makers are celebrating and chanting for success for an increase of enrolments in JSS. While this is a good development, it loses its meaning when the access is not balanced with quality ... it is our expectations that children should attend schools for the sake of gaining skills and knowledge necessary for their future lives. Failure to meet this basic role of education, celebrating for students increase in JSS does not make sense. (ST. 2)

Similarly another respondent had the following to say;

Although the progress on the number of students enrolled in JSS in Tanzania is praiseworthy, the quality of learning is still poor. It is evident that the increased access to education has led to reduction of efficiency of the school system, a situation which ultimately detracts the available initiatives from the noble objective of providing quality SE as stipulated in the Education Sector Reform and Development Programme. (ESDP) (HM 3)

Most respondents shared the view that the massive increase of secondary school enrolments was not only placing a considerable strain on an already weak education system, but was also leading to overcrowded classrooms; a situation which has consequently resulted in producing JSS leavers with low quality academic achievements that deviate from community expectations. Most respondents appeared to share the view that the current policy in place was not aligned with society's expectations. Such a situation is also described by respondents as contributing to the failure of the policy to answer both society's

needs and contextual challenges. A burst of anger was evident in one of the respondents who said:

At a time when countries like the USA, China and India are producing the masses of scientists and engineers upon which they know their futures, all we see from our government is politicisation of policy goals towards developing quality SE in schools. As such, the country has been developmentally dormant scientifically and technologically. (ST.7)

Data from both interviews and focus group discussions revealed that most respondents held the view that the Tanzanian education system, through national policies, needed to focus on not only providing the required training in scientific skills to meet growing global challenges but also in producing a mix of competencies that would make all JSS graduates confident in pursuing science careers.

8.1.10 Curriculum Irrelevance

Curricular irrelevance and context irresponsiveness were identified by most respondents as barriers towards providing quality SE. Table 13 shows that almost all respondents shared the view that SE was irrelevant to Tanzanian life. Most respondents were concerned with the ability of the curricular in practice to keep school children in touch with their culture, society values and being able to face their futures. One respondent said;

It is unfortunate that the education system in most of our schools is characterised by the practice of teaching a wide range of subjects which are full of topics that don't really connect with the students' daily experiences. This practice has led to a situation whereby the school learning experiences are disconnected from socio-cultural Tanzanian values and the students' daily lives. To be honest the irrelevance and context irresponsiveness of the curriculum has led to a situation whereby learners have been leaving the school neither able to do any useful things to their society nor capable to face their life challenges using knowledge gained at school. (ST. 3)

The respondents further shared the view that the SE curricular at JSS was not able to develop holistic individual talents and were not giving any room for creativity and/or opportunities for students to excel in fields of their choices. Though the Tanzanian science curriculum is claimed to be learner centred and competence based, most respondents, especially teachers, identified with the idea that the curriculum was still a teacher centred curriculum; the type of

curriculum that does not take into cognizance the growth and development of learners' abilities.

Data from the interviews showed that most respondents believed that the JSS curriculum had not fulfilled its goal of inspiring students to be self-reliant individuals who could think for themselves and be useful to their society. Most respondents felt that curricular related factors such as content centeredness and certification focused curricular emphases contributed to the inadequacies of the JSS science education.

The majority of respondents felt that SE curricular at JSS level was not focused on equipping students with the necessary skills and knowledge to meet their educational challenges that students are likely to face in their futures. As such, they considered the need for parents' and teachers' roles to be supplementary to each other, in that while parents had to help students to develop more interests in science when they were at home, teachers had to organise the teaching and learning process in such a way that learners' interests could be nurtured and strengthened.

The respondents, especially science teachers, complained that SE instructional time allocated for each learning unit in the syllabi was not enough as it was constricted by the school time table. It was therefore considered by teachers that the school timetable at JSS should either be extended beyond 3.00pm if they were to cover everything included in the syllabus, or that the learning units had to be reduced to match the time available.

8.1.11 Poor Command of English for both Teachers and Students

Poor command of English among teachers and learners was identified by most respondents as having a great impact on the learning and understanding of the subject matter, and on the whole process of developing skills and knowledge in science. More than 60% of respondents, especially science alumni, teachers, students and policy makers, shared the view that English language as a medium of instruction was another impediment to quality learning in science. Most of them (see Table 13) noted that a poor command of English for both teachers and students was an impeding factor that caused most students and teachers to struggle in making sense of the subject matter.

Some respondents (24%) disagreed that English was an obstacle for providing quality SE in schools. This group of respondents, mainly the parents, believed that fluency in the English language (as a language of instruction in science subjects) was an important indicator for quality SE. As such these parents believed using English in school was necessary because fluency in English among learners guaranteed the quality of education being provided. Also the percentage of disagreement rose due to comments by teachers who did not consider that English was a problem for them. These comments by teachers and parents were in contrast to the students' views; they complained that English as a medium of instruction had most of the time led them to fail to comprehend what was written or taught, a situation which consequently forced them to resort to memorisation. The science alumni, on the other hand, shared the view that together with other factors, English language was the most limiting factor in science learning as it was not only limiting the students' easy understanding of science subject matter but it also contributed in alienating them from their traditional ways of knowing. One respondent added:

We cannot close our ears and deny the fact that English has in most of times been identified as a limiting factor for students to do well in national exams. Stories from students are very clear that they are not enjoying their learning with a use of English. I personally think that continuing to hold on to English as a language of instruction is similar to celebrating a linguistic enslavement. I want students to learn using the language they are conversant with. (SA. 6)

Another complaint from students was the concern that a limited proficiency in English language as a medium of instruction among them, led to most of their science classrooms being limited to teacher-led activities, where they remained passive recipients of a body of knowledge that they could not understand. Most respondents believed that the English language, as one cultural aspect of the west, was constantly in conflict with students' realities in science classrooms. This conflict was positioned as a crucial factor in learning which if not addressed would likely have serious impacts on science in the country.

Most of respondents labelled the English language as a part of culture that did not guarantee non-English language learners an understanding of what was being taught in science classrooms. In most cases, respondents expressed the

idea that student learning in the main had been hindered unconsciously by the use of English as the language of instruction.

8.1.12 Inadequate Pedagogical Approaches among Teachers

The inadequate pedagogical approaches among science educators were identified by most respondents as having a negative impact on efforts to provide quality SE experiences in schools. The follow up interview with most respondents about the adequacy of pedagogical practices revealed varied views. Figure 10 summarises the interview responses regarding the adequacy of pedagogical approaches in SE.

Figure 10 reveals a high percentage of agreement on the fact that there are inadequate pedagogical approaches in SE classrooms. This finding is supported by the questionnaire responses in Table 13 whereby more than 90% of respondents shared the view that inadequate pedagogical approaches among teachers had resulted in a failure to support the students' traditional teachings nurtured at home, a process which was described by respondents as leading to the loss of the students' desire to learn science and to avoid it as a future career. Most respondents considered that teachers and curriculum developers needed to shift towards pedagogical procedures that were both learner-centred and responsive to learners' needs and desires.

The respondents shared the concern that pedagogical practices were important factors for quality SE in schools. Data from the interviews showed that most

respondents linked quality pedagogical practices with teacher competences. One student had the following to say:

In meeting our individual learning needs, we need teachers who can challenge our brains, who are available to us in case of learning difficulties, who are willing to help us become like them, who can motivate us to study science, who love to teach and are passionate with us. In fact I want teachers who are like parents at school but friendly ... for me with such qualities it is possible for us to meet our individual learning desires. (S.4)

The students also shared their concerns regarding a number of other pedagogical challenges, including the unavailability of varied teaching approaches that would orient them to become problem solvers, the unavailability of enough instructional time and the absence of remedial classes to help learners in cases of learning difficulties. During a follow-up conversation to ascertain why teachers were reluctant to help, the teachers denied the claims by insisting that they were always accountable for students' learning. During the informal interviews, teachers identified that they were always available for students learning problems and they made sure that all necessary materials for learning were at the students' disposal. However, contrary to the aggregated responses from the teachers' interview, Table 15 (Items 1, 4 & 5) shows evidence of low percentages for teacher assistance with students learning.

Table 15: *A summary of teachers' questionnaire responses regarding the teaching approaches used by teachers to facilitate students learning in science (N=16)*

S/N	Statement	Responses (%)	
		YES	NO
1	Availability of teachers for consultation after a lesson	25	75
2	Encouragement of students to ask/discussing with friends the areas of difficulty	87.5	12.5
3	Asking the students to read the notes	68.7	31.3
4	Conducting tuition classes after school hours	0	100
5	Preparing remedial classes	12.5	87.5
6	Making available all the necessary textbooks and the reference books for science	75	25
7	Orienting the students towards becoming problem solvers through many experiments	18.7	81.3
8	Being accountable for the students learning progress	75	25
9	Enough time is allocated for discussion of the subject matter during classroom hours	31.3	68.7

Although the findings in Table 15 shows teachers' responses are high on student involvement in learning (Item 2) and the use of the pedagogical methods that incorporate discussing areas of difficulty, it was identified by students in a follow up group discussion that teachers were still using a more traditional model of pedagogy (for example, lecturing copying from the blackboard, and with little interaction between teachers and students). During the follow up interview about such pedagogical discrepancy, teachers argued that their inadequate in pedagogical approaches was due to lack of teacher developments programs. Such challenge was also echoed in students' voices who shared the view that the SE pedagogical approaches were not responding to their current and future learning needs. One student added:

I have never been happy with my learning since the day I chose to opt for science combination ... things seems to be very difficult for me and my friends; we are not sure whether we shall pass our final national examination. Teachers are not making things easier for us. For example, I have no chance of learning on my own ... all that I do must originate from my teacher...we neither have an autonomy to learn ourselves nor [are we] allowed to explain science in own ways. (S. 4)

Most students and science alumni were not comfortable with the way science knowledge in JSS was being presented. These respondents shared the view that presenting science as an established body of facts and non-challenged body of knowledge was not right because it limited the chance for learners to question its viability to their own contexts.

All respondents appeared to converge around the idea that students would be capable of excelling in science if they were provided with problem solving skills, culturally and contextual based instruction which would help those grounded in traditional knowledge to easily clarify and connect with science concepts and ideas.

8.1.13 Irrelevance of Science Content in Science Text Books

The irrelevance of science content in most science textbooks and reference books was identified by most respondents (81%) as being one of factors that contribute to the poor quality SE in schools. Most of respondents complained about the poor relevance of the science content to learners' individual and contextual needs. One respondent said: *"It is an absurd practice to see books and other learning materials that were culturally intended for schools, colleges*

and universities in Europe and North America being used in Tanzanian schools to teach our children” (CD.3).

Science alumni raised a concern that western publishing companies like Oxford and McMillan had always contributed immensely towards the alienation of Tanzanian students from their own culture, by providing texts that are culturally un-contextualised. One respondent said:

How can Tanzanian youths develop new insights to solve problems in the context of their own culture, while the culture portrayed in books comes from other cultures? I personally see the need to focus on cultural and contextual science knowledge, which is commonly understood by learners before looking at the global general science. This would help our learners develop skills to face both their contextual challenges and global ones. (SA.8)

Most respondents were also concerned about the foundation knowledge in SE as an important aspect in developing strong career bonds that are necessary for controlling the interests in science.

Interview data also revealed that most parents and SE alumni believed that today’s SE present only a half block of science knowledge through the failure to integrate traditional science knowledge into present science classrooms. They also shared a view that science knowledge had to broaden its view to be able to capture more of the Tanzanian context than that of the Western World. One parent said:

In today’s schools children are learning how to cook Chinese food during Nutrition and Cookery class and while that it is good, I think more focus could be directed to our local food stuffs whereby students could learn how to cook them. In so doing it could help them promote their own traditional foodstuffs. I would prefer to see the curriculum content putting more emphasis on local dishes and traditional ways of healing. (PA.2)

In the quest to create relevant science content, most respondents appeared to share the common view that there were lots of challenges towards achieving this including the challenge of connecting SE to the learners experiences and the challenge of overcoming the problem of dysfunctional and inapplicable science content to the Tanzanian context.

8.1.14 Ineffective Strategy toward Provision of Quality SE

Ineffectual government strategy towards improving the quality of SE in Tanzanian JSS was identified by more than 60% of respondents as being one of the factors that contribute to the poor quality of SE. Most respondents, except the students and parents, shared the view that while the call for each ward to build its own secondary school was meant to help all Standard 7 leavers to have the chance to access ordinary secondary education, such a process had harmful impacts on the aim of developing a quality SE system. Most respondents shared the concern that this strategy was insensible to the aspiration to provide quality SE as it exposed schools to three major challenges: the challenge of large class sizes featured by- a teacher/student ratio of 1-70 - a situation which did not indicate a friendly learning environment for learners; the challenge of fitting such science class sizes into forty minute periods because of the bigger number of subjects per educational level, and the challenge of keeping the students engaged with science studies as potential future careers.

Most of the respondents believed that the government had not fulfilled its responsibility to make sure that the increase of student enrolments would not affect the quality of education offered in those schools. As a result of such government failure, students in the newly built JSSs generally performed poorly in their final Form 4 examinations. One respondent added that:

In my view, developing quality SE depends on the government commitment and the priority in achieving the goal. At present it is clear that the government priority is put on increasing the students' enrolments at all levels. Yes it is a good idea for everyone to have an access to attend the JSS education but what is the use of it if the learning in such schools is poor? I would be happy if the government's intention to increase the enrolments in JSS could go in tandem with the improvement of the educational experiences provided in these schools. (SA 2)

Most respondents considered the need for openness to criticism in addressing the problem of uncontrollable enrolments in JSS as it had started showing some signs of negative impacts on the efforts to provide quality SE.

8.1.15 Ineffective Assessment Procedures

Poor assessment procedures in science were claimed by most respondents as limiting factors for quality SE. Except for a few policy makers (about 9%) who supported the current SE assessment practices as being effective in evaluating

the students' learning, more than 90% of respondents were in agreement over the idea that assessment practices had failed to serve as stepping stones for learners to not only to gain vital knowledge and skills, but also to proceed on to higher levels of education. The science alumni and teachers shared the view that the current modes of assessment in Tanzanian SE were completely paper-pencil tests that were directed towards testing the cognitive ability of students only. In the interviews the science alumni appeared to agree with the idea that the mode of assessment (summative) in place was neglecting two important aspects of education outcomes (attitudinal and value changes) in the learner. Most respondents believed that the assessment practices had in most cases played a role of not supporting the students' ability to develop necessary skills in science studies.

The teachers' questionnaires regarding the assessment designs in SE revealed that many problems in SE originated from SE assessment procedures. The findings shown Table 16 are the aggregated responses of teachers towards science assessment procedures.

Table 16 *Summary of teachers' questionnaire responses regarding the nature of assessment procedures in Tanzanian science classrooms (N=16)*

Assessment criteria	Responses	
	YES %	NO %
Science national examinations usually measure the following		
1. Understanding of the concepts	56.3	43.7
2. Science skills	25	75
3. Attitudes	6.3	93.7
4. Ability to apply knowledge	18.7	81.3
The purpose of measuring is		
1. Grading for the sake of pass and/fail	93.7	6.3
2. Reporting the students' progress	62.5	37.5
3. Identifying students misunderstanding	12.5	87.5
Tools for assessment include		
1. Written tests	62.5	37.5
2. Assignment/ projects	31.3	68.7
3. Practical test (lab work tests)	6.3	93.7
4. Oral quizzes	43.7	56.3

While more than 60% of the respondents agreed that the science national examinations usually did not adequately measure students' competencies,

knowledge, or attitudes, the findings also showed that such examinations were limited to ascertaining correct/incorrect practices identified for the sake of pass and fail purposes only.

Table 16 clearly shows a pattern where there is a neglecting of some important student traits during assessment, either as a result of poor assessment tools, or of poor purposes to assessment procedure. The findings presented in this table show low scores on aspects like attitude or the ability to apply knowledge. Table 16 also shows that the grading has been reduced to a pass/fail the process which is likely to limit the possibility of using diverse typologies of the assessment tools.

Data from interviews show that with exception of parents and students, most respondents shared the view that the examination system was a major problem towards providing quality SE in JSS. As such it was not possible to gain the trust of parents and students with regard to their education system if the academic results were not good. Parents and students on the other hand appeared to judge the school performances and the quality of SE offered based on public examination results and the admission rate to the tertiary education.

Overall, respondents' comments reveal that the current examination practices are inadequate in monitoring learner progress. This is evidenced by the comments made by both teachers and science alumni that most of the practices in use were summative in kind, and their purposes were limited to ascertaining the pass/fail grades among learners, at some points measuring what students had never learned. Table 16 shows that it is only 12.5% of responses that identified to use formative assessment. For most of the respondents this situation contributed in limiting the students' ability to develop their interest in SE. As such most of them shared the commentary that there was a need for schools to switch from summative to formative assessment; the assessment procedure which could be undertaken for the sake of effectively managing students learning.

8.1.16 Ineffective Link between Theory and Practice of Science

The poor link between theoretical science knowledge learned in schools with real practices in the job industry was also identified by most respondents as having a negative impact on the provision of quality SE. More than 90% of

respondents identified a weak link between science theory and practice. During the interviews most respondents appeared to share the view that there was a lack of availability of industries which could build the links between theoretical science knowledge that students gained at school to the real practice. As such, most respondents consistently considered it necessary for the students to be provided with opportunities to visit nearby industries or factories and get involved in industrial work so that they would see and experience how the theoretical knowledge obtained in the classrooms could be used in practical environments.

With an absence of laboratories in many schools, most science alumni shared the view that science in secondary schools was not supposed to end in the classroom or laboratories but in industries where students could actually go out and demonstrate some of those skills they had learnt in their classrooms. Building a relationship between schools and the factories/industries was identified as important by science alumni as it increased the chances to assess not only how teachers were doing, but also in assessing how the students could be helped to rectify their mistakes in learning.

Generally, the provision of quality SE was described as facing many limiting factors, stemming from multiple sources. In many cases, the prevalence of these factors was identified as impeding or reducing the efforts to achieve the goal of providing quality SE in schools. In this regard, section 8.2 focuses on addressing different interventions or strategies to overcome the existing impediments for providing quality SE in schools.

8.2. Strategies towards Provision of Quality Science Education in Tanzanian JSS.

In light of the challenges and barriers towards the provision of quality SE, respondents identified several strategies that could be utilised to provide quality SE in JSS. The findings in this section answer the question of what could be done to address the barriers influencing the provision of quality SE in Tanzanian JSS. Table 17 summarises the questionnaire responses from all respondents regarding promising strategies that could be employed to provide quality SE in schools. The students' views are not included in Table 17 because they were already obtained through focus group discussions.

Table 17: *Approaches or strategies to help in developing quality SE as identified by the respondents (N=43)*

C/N	SITES A & B			
	Strategies towards provision of quality SE in Tanzanian Junior secondary schools	Responses (%)		
		Agree	Not sure	Disagree
1	A need for policy review to address the current challenges in SE	100	0	0
2	Improving learning support services and increasing the educational pathways	91.1	0	8.9
3	Strengthening governance, management and accountability in educational sector.	91.1	8.9	0
4	Improving the status of teachers and their teaching profession	88.9	6.7	4.4
5	Strengthening teacher development programs	100	0	0
6	Redefining the science curriculum focus	88.9	11.1	0
7	Improving the collaboration among the educational stakeholders	80	8.9	11.1
8	Building supportive learning environment.	71.1	17.8	11.1
9	A need for pedagogical reforms in SE	91.1	8.9	0
10	A need to develop a common understanding about quality SE	95	1	4
11	A need for sharing the responsibility of providing quality SE	87	3	10

The questionnaire responses from Table 17 were combined with data from interviews, and focus group discussions. The following sections detail respondents' views on various strategies for overcoming the challenges in SE.

8.2.1 A Need for Policy Review to Address the Current Challenges in SE

The need for a holistic review of the policies governing the provision of quality SE was identified by most respondents as an essential task. All respondents (see Table 17) shared the belief that, among other things, there was need for policy review. They believed that this process would lead to producing effective policies which would provide an avenue where societal values and expectations would be reflected in the school science curriculum.

One respondent said that:

I am hoping that the new policy, which is on its last stages to be produced, will be effective and responsive enough to the Tanzanian societies. I hope issues such as the use of Kiswahili in schools as a language of instruction and the inclusion of the Tanzanian cultural values would be given special attention. It is my wish that the government will improve its commitment and support for efforts to provide quality SE in schools. (ST 5)

Policy makers and science alumni shared the view that there was a need to strengthen the department of policy planning to make sure that all educational issues received quality coordinated planning, budgeting, management, monitoring and evaluation. While requiring the policy to clearly state the strategies to combat critical issues in SE, most respondents believed that there was a need to learn from other excelling countries with similar contexts to Tanzania on how they had succeeded in providing quality SE in schools.

Most respondents shared concern about whether the huge investments by parents and communities for their children's education were equal to the value of the education provided. For example, parents were convinced that sending their children to school was becoming a waste of time unless serious efforts were made to address the quality of teaching and learning in schools. For them there was a need to re-orient the priorities in education so that all the JSS learners would complete their JSS science education having gained the knowledge and skills necessary for them to be useful in their society.

As a solution to the clarity of policy objectives, most respondents considered it necessary to set clear objectives on how to co-ordinate the contributions of educational partners (public, private, local, non-governmental) to meet the expected objectives of providing quality science education in schools. With the increase in complexity of JSS most respondents also suggested monitoring educational inputs and resources for better educational achievements. Most respondents wanted a balance between the educational inputs and the educational outcomes so that education offered in schools would help the learner meet the growing demands for post compulsory education and the global job market.

In making sure that the policy had sustainable goals most respondents shared the view that it was necessary to develop the national education quality standards and education monitoring schemes, which in turn would ensure that learning outcomes work in tandem with both national and international standards of education.

8.2.2 Improving Learning Support Services and Increasing Educational Pathways

In the quest for overcoming the challenge related to learning support services in education most respondents (more 90%) were in agreement with the idea that there was a need for adequate and modern learning support services and facilities. The commonly identified learning facilities included things such as computers, laboratories and instructional learning aids. The respondents also identified several learning support services including guidance and counselling units, up-to-date libraries, learning support units and well-furnished laboratories. The respondents believed that adequacy of these facilities would solve the problems of overcrowded classrooms and the current state of inadequate and underequipped facilities. One respondent said:

I think first of all we need to have a variety of science learning resource centres that will maximise the learners options to get informed on the development of their young careers in science ... while having support learning services such as career counselling and guidance and well-furnished labs and libraries would serve a lot there is also a need to go beyond making students learn better by exposing them to other alternative educational pathways for them to be productive in the society. (ST 6)

Most respondents also had a view that the presence of strong support services required further funding allocation. They identified that the availability of sufficient funds was important because it would help in building new classrooms and laboratories so that class sizes could be reduced, and laboratories equipped with chemicals and reagents and providing textbooks in the library. One respondent mentioned the following:

In my view the funding is the heart for improving learning services ... when SE is not adequately funded, its foundation becomes weak; consequently the products of such an education system also become intellectually weak. I personally see a need to ensure that funding is adequately provided so as to guarantee good learning output from the available learning services. (ST.4)

Some policy makers had the feeling that the minimal material and financial support from government which had been given to schools had not been used for its intended purposes. Science alumni and parents shared the view that most resources allocated for schools' development were not received by specific schools. In cases where such resources reached the schools, they were either inadequate or misused by schools. As such they felt that there was a need for tracking all resources to ensure that there was proper and sustainable utilisation of resources available. While a lot could be done, most respondents believed that there was a need to consider how all support services could be redirected to focus on positively impacting learners.

8.2.3 Strengthening Governance, Management and Accountability in the Educational Sector

Management, leadership and accountability in education were described as being critical factors influencing the provision of quality SE in Tanzanian JSS. More than 90% of respondents were dissatisfied with the way the education system was monitored. One respondent commented that:

There is too much reluctance among the educational authorities especially when it comes to provision of quality SE in our schools. What is happening in schools today is a result of negligence and lack of committed monitoring practices to make sure that our children learn what is supposed to be learnt. We need JSS to be well monitored so that the experiences that students get at school conform to societal expectations.
(SA. 1)

Most respondents were in agreement with the idea that the inadequate management linkages and synergies within the education sector had always been limiting efforts to deliver quality SE. In view of this, most of them commented on the need to strengthen these linkages so that the developments in one sub-sector of education could inform the developments of the sector above and below it. One of respondents held the following view:

You would expect that the review of science curriculum in JSS that has occurred recently could have informed the practices in the NECTA, school inspection practices as well as funding in education ... but this is not the case for this country because, looking at a simple example of recent practices, the enrolment expansion at JSS level has not adequately informed the planning sector about an increased enrolment in the teacher training institutions, recruitment at advanced secondary and post-secondary education levels...that is why we are facing problems of shortage of teachers, big class sizes which all of them negatively influence the quality of SE.(ST. 1)

Most respondents also commented that for an educational system to perform better it had to have effective managers and leaders who not only feel highly accountable for the responsibilities assigned to them but who are anxious about meeting society needs and expectations.

8.2.4 Improving the Status of Science Teachers and their Profession

The efforts to improve the value of science teachers and their profession were seen as being a fundamental initiative towards meeting the goal of providing quality SE in schools. Table 17 shows that 88% of respondents were in agreement with the idea that quality SE could possibly be provided in schools with the improvement of the status of teachers and their teaching profession. Despite a few disagreements, most respondents shared the view that teachers were important individuals for developing positive learning traits among learners, particularly promoting positive physical, mental, psychological, and moral development. Most respondents believed that the provision of quality SE in JSS required the availability of qualified teachers, the presence of active teacher development programmes and on-going professional growth related programmes for teachers.

Most teachers believed that if a supportive working environment for teachers were created then Tanzania would still have a chance to partake in developing science and technology nationally and internationally, a vision that has never been attained since independence. Several initiatives were favoured among respondents, including:

1. Revisiting the aims of teacher education to meet the current needs in the education sector;
2. Developing a plan to ensure that those trained through the fast track of three months as it was in the period between 2000-2010 in the bid to address teacher shortages, receive a total two-year package of training within three years;
3. Complementing the scheduled short block teaching practices during pre-service training at teacher training colleges and universities with a one year school based training with an effective well-coordinated system of supervision, mentoring and face to face support;

4. The revival of Teacher Resource Centres (TRCs) in all districts coupled with adequate provision of human, financial, physical and material resources for regular professional development and support of teachers;
5. Restoration of the dignity and respect of the teaching profession by improving its value to the communities surrounding the schools;
6. Professionalise teaching by establishing teacher licensing boards to control the professional intruders who have turned the teaching profession to an occupation for everyone;
7. Development of a performance appraisal system appropriate for the teaching profession, as well as implementing social service schemes to improve the economic wellbeing of teachers;
8. Improving the working and living conditions of teachers, especially in rural and hardship areas.

Most respondents wanted the teaching profession to be considered similar to other paying professions in terms of support and respect.

8.2.5 Strengthening teacher's professional development programmes

Teacher development programmes were identified by almost all respondents as being an important component for providing quality SE in JSS. The science policy makers and science alumni also considered the need for active teacher professional development programmes, because it is through those programmes that teachers' knowledge and skills get updated.

Most respondents, especially educators and science alumni, wanted the government, through the Ministry of Education, to launch special teacher development programmes that would help to improve the efficiency of science teachers.

In the quest to improve teacher professional programmes, the data from the interviews revealed that most respondents believed that effective teacher development programmes could be possible if the following were done by the government:

1. Supporting subject association meetings in various schools;
2. Creating avenues where teachers of science could meet regularly to share their professional challenges and help them put in their profession best;

3. Organising refresher courses, in form of seminars for science teachers, inviting more knowledgeable and experienced lecturers or specialists to talk to science teachers about how to address the new developments and challenges in the profession;
4. Supporting science teachers' camps geared at developing science education in various centres countrywide, not only for some few schools or districts.

Contrary to this, the students emphasised the need to have teachers who could; provide them with new perspectives of knowing, enabling them to identify the usefulness of science ideas in their lives, and not limiting their teaching to the description of ideas, events and facts.

The students wanted teachers who could respect and care about them, who were good mentors, persons who did not only stick to textbooks and out-dated theories in teaching, but who engaged them in learning rather than constantly 'telling' them what they had to learn regardless of whether such knowledge was connected to their lives or not. The students also wanted teachers who could take as much personal interest in them as parents, aunts, uncles and grandparents, as well as providing the support which was actually missing in most of their homes. For students professional development was nothing if it did not produce teachers who could assume the roles of heroes, mentors, life coaches and role models for their learning.

8.2.6 Redefining the Science Curriculum Focus

Curricular refocus was identified by most respondents as being a vital step towards providing quality SE in schools. More than 80% of the respondents (as shown in Table 17) identified the need to redefine the curriculum focus towards a more learner centred, multidisciplinary and flexible curriculum. Despite a few disagreements, most respondents wanted schools' science curricular to focus more on the use of relevant local and real-life examples. Such an emphasis was identified by school inspectors and science alumni as being the bedrock for creating a relationship between experiences provided by science subjects as academic disciplines and their being consistent with societal needs and expectations.

A common view among respondents was that reforming the curriculum focus was important for several major reasons: To enable students to use learned knowledge to solve the problems they faced in their everyday lives, to help students eliminate the achievement gaps that exist in today's curriculum as well as supporting better achievements across the entire school SE system, to encourage and nurture students' interests in science without coercing or forcing the students to opt for science as it is practiced in most of Tanzanian schools today, to assist learners to improve their scientific literacy, and to ensure that science literacy is useful to their everyday lives and provides a clear link between what is learned in schools with the realities that learners face every day.

Most respondents shared the idea that there was a need for the curriculum content to be attuned to more relevant issues, ones that address the needs and aspirations of learners and their real environment.

8.2.7 Improving the Collaboration among Educational Stakeholders

Collaboration among SE stakeholders was described as an important component for developing a strong and quality SE system. Most of the respondents (80%) shared the view that there was a need to establish inter-departmental relationships among the four vital departments in the Ministry of Education and Vocational Training. Such departments mentioned include TIE (curriculum development), TEA (education funding), the inspectorate department (education monitoring) and the NECTA (evaluation of student performance). Most respondents considered that there was a need to develop strong relationships among these departments because doing so would help in producing a powerful education system.

Data from interviews showed that most respondents held the common view regarding the necessity to develop good partnership patterns with other interest groups. An example of these partnerships was identified as including: school/community groups, teachers/parents, schools/business organisations, and other important relationships between key education players (such as non-governmental organisations, national educational institutions, universities and religious groupings) and JSS to improve SE. For most respondents, such partnerships were important because quality attributes of education were likely

to emerge from good interactions between the parties involved in the relationship.

Therefore encouraging a broad community involvement and fostering active community involvement as partners in school development was argued by most respondents as being important for not only improving the speed at which excellent standards in SE could be achieved but also such partnerships and alliances based on common interests, mutual respect and credibility among stakeholders could serve as powerful forces in shaping learners into competent science professionals.

8.2.8 Building a Supportive Learning Environment.

A supportive learning environment was identified by the respondents as being an important factor for successful provision of quality SE in schools. Most respondents (more than 70%) considered it important to have a supportive learning environment as a boost for academic excellence. One educator emphasized that:

It is my dream that schools are made better places to learn ... I believe excellence in any educational endeavour has a lot to tell about the learning environment behind any school successes. If you look at the well performing schools you will find that the learning environment in those schools plays a big part ... I think the learning environment requires a huge consideration when planning for improvements of educational outcomes from schools. (HM.1)

The consistent view among most respondents was that there was a need to develop a supportive educational environment that could accommodate and strengthen teachers' capacities to implement the existing curricular framework while improving their abilities to use context-responsive and improvisational instructional practices. For most of respondents, it was important to remove all barriers to learning so that learners could learn easily and smoothly.

The students on the other hand, wanted the comfortable learning environment characterised by the presence of both informal and formal support programmes that would ensure every child loved schooling.

8.2.9 A Need for Pedagogical Reforms

Pedagogical practices, such as teaching approaches and classroom management skills, were identified by the respondents as being among the

major determinants for quality science learning. While acknowledging the need to have students who were ready to learn, more than 90% (Table 17) of respondents mentioned the need for pedagogical reforms as essential initiatives for developing student engagement, persistence, and interest in science and its related careers.

Most of the respondents, especially students, wanted a mode of teaching practice that would be based on more practical work such as group work, interactive discussions, and hands-on experience, rather than just lectures and homework. They wanted teachers who could connect with them in their worlds, helping them to meet their individual learning needs. One respondent said that:

It is weird to mention but this is the truth ... some of us here attend school because we need to and we do it to make our parents feel good, but we know for sure that teachers are neither helping us to learn what is important for us nor helping us to make things easier in science. (S.2)

Data from the focus group discussions showed students held the common view that they could be more engaged in science if they had teachers who could facilitate more hands-on science, where they could experiment, discuss, and reflect on what they had learned with the option to then redo the assigned activities. This view is contrary to the so called “alternative to practical” approach (the famous theory, lab related learning) which is more common in Tanzanian schools. The students desired meaningful, authentic activities and active science classroom sessions. They therefore emphasised the need for pedagogy that stressed participatory approaches of teaching which would allow them to work with each other and hear stories that illustrate science in their lives.

On the other hand, most science alumni and the educators shared the view that they could be happy if more time was allocated for practical learning than theory. For them it would be better if four periods (160 minutes) could be allocated for practical and two periods (80 minutes) for theory per week. Looking at how things had changed in the job market, where graduates need to demonstrate what they can do rather than what they know, the science alumni considered the need for a pedagogical shift from “*more room for talk and less room for practical*” to “*less room for talk and more room for hands-on-activities (practical)*” to be critical.

8.2.10 Developing a Common Understanding about Quality SE

Following the challenges of differing views towards quality SE as presented in earlier sections of this chapter, most respondents (95%) mentioned the need to create a common understanding about quality SE. Such a need was identified by most respondents as being important for several major reasons including; attaining a united voice and collective action among affiliates in SE, creating a platform which can support the stakeholders in piloting promising practices towards quality SE and developing general promising principles on which a common focus on quality SE can be established. One respondent commented that:

Considering the differences of contexts from which SE stakeholders reside, it is possibly difficult to have a common view on what quality SE should look like. But we cannot ignore the fact that having a consensual definition about quality SE is important in any initiative to provide quality SE in schools and so far this issue has not only been an advocacy issue but also a dominant agenda in most national and international SE debates ... I would love to see this happening in my country, whether formally or informally. (DE 2)

Most respondents shared the view that in achieving the aspiration of providing quality SE in schools it was important for all stakeholders to be aware of what quality SE means as well as what it takes to be able to provide quality SE and what roles each of them have in achieving it. As such, most respondents considered the need for establishing common ground, where national efforts to develop quality SE could be monitored and a place where global perspectives about quality SE could be translated into Tanzanian educational priorities. It was apparent that most respondents were ready for collaborative dialogues and table discussions to debate a common national focus regarding quality SE in schools in light of the existing contextual educational challenges.

8.2.11 Need for Sharing the Responsibility of Providing Quality SE

Successful shared responsibility in providing quality SE was identified by most (87%) respondents as being important in improving SE outcomes, increasing community engagement and improving the system's efficiency. However, in order to have effective stakeholder engagement in the core objective of improving the quality of SE, most respondents considered that there was a need for developing new structures, roles and capacities to foster meaningful

and reciprocal relationships between stakeholders and that of various educational partners.

Most respondents shared the view that partnering with different education stakeholders such as community groups, business groups, government departments, friends of education, donors (internal and external), clergy, educators, healthcare providers, faith-based institutions, and universities was essential in determining which experiences needed to be brought into the school, depending on students' and their community's specific needs.

Bringing all stakeholders together to harmoniously work towards the common focus of providing quality SE in schools appeared to be important to most respondents, as it was likely to be useful in two ways. Firstly in creating trusting, even and open communication, enabling risk-taking and fostering shared responsibility, and secondly, in creating an environment where everyone is enrolled in making sure that both students' needs and that of the society are being met. A small percentage (13%) of respondents included the ideas that:

1. Providing quality SE in Tanzanian JSS was solely the responsibility of the MoEVT. In reality however, the documents analysed revealed that four Ministries such as PMO-RALG, MoCD-GC, and MoEVT all had a role to play in ensuring quality SE is provided in schools;
2. Teachers can do it all, no matter the circumstances. The idea that through intellect, hard work, dedication, and determination a teacher could single-handedly overcome inadequate resources and other challenges towards providing quality SE came through strongly from parents and students. However, teachers appeared to be against the "stand alone" view where everything at school is left in hands of a teacher.

In a follow up interview, one respondent said:

In my view neither the MoEVT nor teachers can achieve worthy aims of providing quality SE alone. By joining hands with the larger SE stakeholders around shared values and common goals, it becomes possible to not only leverage, support and sustain SE reforms that will have a genuine, lasting impact but also helps to create a shared responsibility whose combined effect is far greater than when one group of stakeholders stands alone. For me, I think a wide-ranging stakeholders' partnership, would likely help to improve the quality of SE in schools. (EA)

Unlike top-down and dictatorial mandates which are common features of failure in most education sectors, most respondents shared the view that the promising plan of action for developing a strong SE system with excellent experiences involves an intense collaboration which is defined by an existence of teamwork and co-operation among SE stakeholders. Most stakeholders considered that through this action plan, the expertise, resources, and funding from all stakeholders were likely to be organised to work towards common goals on which they all agree, using methods that they all accept and expecting similar outcomes from their invested efforts.

8.3 Summary

The first part of this chapter highlighted a number of factors that limit the provision of quality SE in JSS. In general, the respondents appeared to believe that the undesirable outcome of Tanzanian SE was the production of thousands of JSS school graduates leaving school without the necessary skills and knowledge to face their futures. Respondents identified this situation as resulting from a number of challenges including inadequate community support, lack of government support, lack of sufficient infrastructural facilities in schools, insufficient teaching and learning resources, ineffective strategy of decentralisation in the education sector, ineffective integration of ICT in education, inadequate student commitments, readiness and interest in learning, ineffective teacher attributes influenced by working conditions, ineffective policy for education, curricular irrelevance, poor command of English for both teachers and students, inadequate pedagogical approaches among teachers, irrelevance of science content in science text books, ineffective strategies towards provision of quality SE, poor assessment procedures in education and ineffective links between theory and practice in science.

Most respondents shared the view that the problems in science seemed to stem from the way SE was planned, practiced, assessed, and monitored. As such, most respondents wanted urgent measures to be taken to overcome these challenges. The failure to address these challenges were seen by some respondents, such as science alumni, as maintaining the legacy of irrelevant, context irresponsive and dysfunctional SE experiences to the life of the learner.

In the second part of this chapter, diverse strategies were identified by the respondents including reforms in: policy, educational governance, management and leadership, learning support services, teachers and their professional status, science curricular, collaboration among SE stakeholders and improving the science pedagogy. However, the most common view among most respondents was the need for increasing the government learning support services in terms of funding. The noted general strategy to overcoming the limiting factors to quality SE focused on developing effective monitoring systems of SE and meeting different learners' needs. The next three chapters (9, 10 and 11) present the discussion of findings which is based on findings presented and literature available.

CHAPTER NINE

DISCUSSION I: CONTROVERSIES REGARDING QUALITY SE

9.0 Introduction

The voices expressing concern about the quality of SE in Tanzanian JSS are not new; qualms have been voiced by other authors including Chonjo et al (1996), Osaki, et al, (2004), and Hamilton et al, (2010). This is an issue for many nations, particularly those regarded as developing countries such as Tanzania which is expanding its school enrolments rapidly to achieve the goals of Education for All by 2015 and the Millennium Development Vision by 2025. In search of ways to improve the quality of SE offered in schools, the Tanzanian focus is now on developing an understanding of the complex interactions that take place at school, as well as an understanding of what is meant by quality SE (Hakielimu, 2007, 2008; Malekela, 2000; Mosha, 2000, Mushashu, 2000). This chapter presents an interpretation of the findings regarding respondents' views about quality SE. Four main factors shape this discussion: insights about quality SE drawn from the literature, theoretical stance, the researcher's positionality, and the findings gathered during this research.

While it has been worthwhile to regard quality SE as one of the factors that play an important role in enabling the individual learner to respond appropriately to a variety of social and cultural contexts, the findings reveal that there are still controversies that need to be resolved for the full realisation of a quality SE system in Tanzania. These controversies include the diverse views regarding what quality means for SE: there are contestable approaches for understanding quality SE, debatable measures for quality SE, varied views about the descriptors of quality SE, and differing goals for quality SE. The details of these controversies are discussed in the sections that follow.

9.1 Diverse Views Regarding Quality SE

Quality SE is identified by the findings as a complex evolving concept which is understood differently by various SE stakeholders, a situation affecting its meaning, design, implementation, evaluation, monitoring, and the entire process of producing the desired outcomes. Many scholars such as Ng (2009), Sallis (2002), Sifuna (2007), and Sumra and Rajani (2006) have invested years in trying to define quality education and envisioning how to achieve it at national

and local levels. Despite the attempts to define it, various controversies still remain. Similar to the studies by Ng (2009); Sallis (2002); Sifuna (2007); and Sumra and Rajani (2006), the findings of the present study reveal a range of views regarding quality SE. The respondents' views about quality SE were framed around the following:

1. *A creed of excellence for the education system.* The findings described quality SE in terms of a specific set of standards (norms and societal values) that are used to shape individual and institutional performances. Most respondents identified quality SE as having attributes of excellence under which SE status, and standards, and the health of the education system can be judged.
2. *As a positive transformational change.* Quality SE was viewed as an incremental process or a transformative change that takes an individual learner from one level of understanding to another. This change involves moral and socio-cognitive change, attitude enhancement and students' empowerment through enhanced learning competencies (see section 7.1.2; and section 7.1.3)
3. *As the achievement of an educational goal.* Quality SE was described in terms of its ability to achieve the aims and requirements of interest groups in education. This involves ensuring that the needs of individual learners are met and that there is greater satisfaction with education in the nation at large. Within this view, the schools are viewed as centres that not only function according to their mission statements in the production of individuals with critical minds, but also make it possible for all education processes to work towards meeting the desired educational goals.
4. *Client satisfaction.* Quality SE in this case was viewed as an educational outcome that is judged on its ability to satisfy the stated or implied needs of the stakeholders and meet or exceed the stakeholders' requirements and expectations. Within this view, schools were identified as being responsible for satisfying the learners' interests, helping them to meet their desires and nourishing and nurturing their passion in science.
5. *Learners' future life determinant.* Quality SE was viewed as a determinant of graduates' futures, their employability, their future

prospects, and their productivity in society after completion of their courses. Section 7.1.5 presented a relationship between what students gained as a result of schooling and the ability of schools to meet students' expectations and their aspirations to develop their preferred professional identities. Similar to Ng's (2009) view, quality SE in this case is related to one that prepares learners for active participation in the broad range of work and community activities affecting the quality of their lives and the lives of those around them.

6. *Human capital investment.* Quality SE in this case was viewed as a function of resource investment, with the amount of investment in education determining the strength of a particular education system and the type of workforce to be produced. In this regard, choosing to allocate more resources to finance education as part of human resource development would not only guarantee to increase social and human capital in the society in which students live but also will help in knowledge creation, innovation and adaptability, crucial features for economic survival.

In view of these varied labels for quality SE, the concept of quality SE is generally described in terms of the investment and consumption value of SE, and how such benefits are distributed across a diversity of stakeholders. The investment component entails the monetary, material and human resource investment; its consumption value includes aspects such as learners' educational outcomes, the social value of SE, the ultimate role of SE on individuals' economic lives, ability of SE to meet the demands of its stakeholders and the expectations of good educational achievement, all of which are accrued as returns of SE among learners after their graduation.

Similar to the studies by SACMEQ (2005) and Sifuna (2007), the findings of this study showed that despite being from similar contextual educational experience, the respondents had different views about quality SE. This situation makes the concept of quality SE elusive, complex and challenging to define.

According to Fraser (1994), Harvey and Green (1993), Mushashu (2000), Sallis (2002), and Sumra and Rajani (2006), the concept of quality SE may be even more challenging to define if limited key players are involved in delineating its

meaning, indicators, and importance. It is argued in this chapter that harnessing different thoughts and harmonising them is an important challenge that Tanzanians need to overcome to generate an agreed definition of quality SE. This process could maximise the possibility of bringing the ownership of education practices into the hands of all stakeholders. This could also make every educational stakeholder feel accountable for educational outcomes and trigger a sense of responsibility, dedication, and conviction among stakeholders to improve quality SE in their JSS. This is possible if pragmatism is used as a theoretical lens to define what is worth learning in science. As argued by Goodman (2005), Haack (2006), and Rorty (2004), a pragmatic perspective would bring together differing perspectives and judge them in terms of their functionality and context responsiveness, workability, sustainability, and usefulness in defining the positive outcomes of quality SE.

9.2 Contestable Approaches for Understanding Quality SE

The findings of the present study echoed five major approaches that were commonly used in describing the concept of quality SE. The approaches identified were similar to those propounded by Curtis and Boulton (1968) and UNESCO (2004), including humanistic, behaviouristic, critical, indigenous and pragmatic approaches. The details of how respondents echoed these approaches to quality science education are discussed in the subsections that follow.

9.2.1 Humanist Approach

According to Khatib, Sarem, and Hamidi (2013), the humanist view in education can be related to the extent to which learners translate learning into social action. Similar to the later view, respondents to this study viewed quality SE as the extent to which graduates meet 'absolute' criteria concerning- for example, academic achievement, attitudinal change, scientific and technological achievements, and improvement of students' behaviour and values. Most respondents, especially students and parents, judged quality SE by its ability to develop an individual learners' potential. This view is humanistic in nature in that:

1. It emphasises concerns and interests of the students intertwining with intellect (Mishra, 2000).

2. It rejects standardised, prescribed, externally defined, or controlled curricular because for humanists these are seen to undermine possibilities for learners to construct their own meanings, and for educational programmes to remain responsive to individual learners' circumstances and needs (Maples, 1979).

9.2.2 Behaviourist Approach

This view was clear within the curricular materials that were analysed whereby a behaviouristic view of quality SE was evident. For example, quality SE in the documents was mirrored by the emphasis on students being led and their behaviour controlled for specific ends. Teachers mostly assumed the role of managers of students' behaviour and therefore became the key players for quality learning. As argued by Curtis and Boulton (1968) this behaviourist view influenced the understanding of quality SE and was therefore judged through standardised, externally defined, and controlled curricular, based on prescribed objectives, and is defined independently of the learner.

9.2.3 Critical Approaches

Findings of this study reflected elements of critical theory which were used to challenge the existing SE system and demanding a change to the way SE was planned, practiced, evaluated and monitored. The understanding of quality SE by science alumni and parents of this study was therefore described with a critical eye that is ambitious for change in SE. This view is similar to that of Freire (1985) who sees critical theory as helping to prompt social change, encouraging critical analysis of social power relations and ensuring that learners participate actively in their learning. While Goodman (2005) related the process of critical view to education as a practice of freeing the stakeholders from externally defined needs; McLaren and Farahmandpur (2003) identified it as a process of helping the stakeholders to explore alternative ways of thinking that may not have blossomed under dominant norms.

9.2.4 Indigenous Approaches

The findings revealed a critical demand for setting the importance of SE's relevance, context responsiveness, and functionality to the socio-cultural circumstances of both the nation and the learner. They have also indicated the need for the local design of curriculum content, pedagogies, and assessment

procedures to be made relevant to the learner. On certain occasions, the respondents were inclined to reject imported knowledge, images, ideas, values and beliefs that were reflected in mainstream education. This view is basically an indigenous based approach for understanding and describing quality SE because, quality SE is viewed as an emancipatory tool from the so called legacies of colonial educational frameworks (Dei, 2012; Ogawa, 2008b). The respondents' point of view is similar to the prominent examples of anti-colonial movements in education pioneered by Mahatma Gandhi (India), Julius Kambarage Nyerere (Tanzania), and Archbishop Desmond Tutu (South Africa). These individuals proposed new and alternative education systems that were culturally relevant (using indigenous approaches). Some of their emphases included education for self-reliance, education for equity and shared power, relevance of knowledge to local people, embracing the social nature of being, and an inclusion of the knowledge of the whole community in schooling (Ryan, 2008; UNESCO 2004). The findings revealed a similar need for emancipation from imported western knowledge towards relevant knowledge. Within this tradition three major emphases were evident in the findings:

1. Emphasising approaches to SE to be contextually responsive;
2. Building learners' capability to fully play a role in defining their own curriculum;
3. Transforming learning processes to move beyond the boundaries of the classroom/school through non-formal and lifelong learning activities.

9.2.5 Pragmatic Approach

The findings of the present study revealed that SE should connect school experiences with learners' real life experiences. This view is pragmatic in nature in that it not only emphasises linkages between what is learned in schools and what exists in real life but also brings to the fore the need to adapt the educational practices that are promising and are likely to have a positive impact on learning (Rosenthal & Thayer, 2011; Tröhler & Oelkers, 2005). The findings also reflected the need for the SE system to mirror the following pragmatic features:

1. Utilitarianism. SE experiences needed to have a utility value of fulfilling the stakeholders' interests, desires, preferences, and expectations;

2. Applicability of knowledge. The practical application of knowledge learnt is given priority so that the education practices do not overload students with science content that cannot be applied and put into practice.

Considering that all these emphases are important, Dewey (1938b) added that because the life experiences change over time, the issue of keeping SE applicable and functional requires a constant reconstruction or re-organisation of learning experiences to meet the challenges of the present world.

The array of these approaches portrays the existence of conflicting views among the stakeholders towards quality SE. It is clear from the findings that while some respondents addressed quality SE in terms of its virtue or in relation to achieving a better life, others described it in relation to intellectual, behavioural and attitudinal change. Such a varied understanding has resulted in dilemmas over whether or not quality SE should be directed at things useful in life, or to those factors conducive to the community's needs. This situation presents a challenge in building a consensus in understanding the concept of quality SE.

This thesis uses a pragmatic perspective to address the dilemma of understanding SE, because as stated earlier in chapter 2, pragmatism is a comprehensive and inclusive perspective that is able to combine diverse approaches towards producing a harmonised and common consensus for appropriate approaches in understanding quality SE (Rosenthal & Thayer, 2011). The decision to take a pragmatic approach in this study is based on the belief that there is no one approach that can claim to be satisfactory on its own in understanding the concept of quality SE, because quality SE is multifaceted, illusive, and value laden (Sallis, 2002). Through pragmatism, the various approaches described earlier in this section can be brought together and harmonised in the process of understanding quality SE (Haack, 2006; Sleeper, 2001; Tröhler & Oelkers, 2005).

9.3 Debatable Measures for Quality SE

The literature indicates that for a number of decades there has been no authentic way to measure quality education (Lockheed & Verspoor 1991; Muskin 1999; UNICEF 2000). Common questions revolving around the concept of quality measures have included: how can we appropriately measure quality

education? Is it enough to use an input-process-output model as a criterion to measure the quality of education? Can a single model be enough to be used in measuring the quality of education? (Sifuna, 2007).

In an attempt to describe how to judge the quality of SE, the findings challenge the existence of solo measures for quality SE. The findings reveal a critical question as to whether or not singly existing measures for quality SE can really measure adequately the actual situation of education processes for any context and cultural background. The respondents, especially policy makers and science alumni, also expressed their feeling that they were uncertain of whether the existing models were technically adequate in measuring the quality of SE *anywhere* in the world, despite the socio-cultural and contextual differences.

Respondents in this study held a variety of views regarding the standard measures for quality SE, including:

1. *Measuring quality SE by looking at the relationship between various educational inputs and student performance (output).* The findings identified a wide variety of SE inputs including: an availability of good educational infrastructure and resources, a quality schooling environment, textbooks, quality teachers, good teacher salaries, good co-operation among stakeholders, a relevant curriculum, quality educational policy, good learning support services, good educational management and leadership plans, improved student/teacher relationships, appropriate collaboration processes in the education sector, conducive learning environments, attention paid to students' physical well-being, and good family involvement in educational matters. The outputs involved students' results on various assessments and/or end-of-cycle examinations. Though this approach might be useful in identifying the inputs that are associated with desired quality SE outputs, Lockheed and Verspoor (1991) and Muskin (1999) have argued that the approach seems to neglect the micro-educational processes at the school, classroom, and community levels from which the aforementioned inputs are processed to create the desired educational outputs.
2. *Measuring quality SE by looking at the efficiency of the education system (i.e., the efficiency of both the internal and external system).* The internal

system's efficiency was described in the findings as including aspects such as the students' enrolment, completion, drop-out, and repetition rates. The external system's efficiency was measured by looking at the outcomes of education or the productivity of school leavers. Similar to Scherens' (2002) view, the respondents related education outputs to the employability of the graduates, the possession of relevant skills and knowledge among graduates, usefulness of the graduates in society, fluency in English language, and a change of economic status of the individual learner after graduation.

3. *Measuring quality SE by looking at the way the content, context, and culture of a particular place are reflected in education processes.* Some respondents judged the quality of SE by using the degree to which SE content was responsive and relevant to the Tanzanian culture and the targeted public who were the final beneficiaries.
4. *Measuring quality SE by looking at the efficiency of educational processes from which inputs were transformed into outputs.* These processes included teaching and learning practices at the school level, interaction within the schools, interaction between the school and the community, accountability and responsibility among school staff members. The respondents, especially students, parents, and the science alumni, were concerned with ways in which the inputs interacted at the school level to produce quality learning experiences, as well as the manner in which inputs were processed to produce the expected outputs.
5. *Measuring quality SE by judging its ability to achieve the national goals of education.* In this respect a quality SE system was measured by its consistency in achieving the goal of providing the equivalent educational experiences needed by the public to meet challenges in the new era of science and technology. The respondents, especially educators, measured quality SE not only in terms of the availability of quality checking mechanisms in education but also in the availability of a strong inspection practice for determining whether national challenges could be solved via schooling experiences.
6. *Measuring quality SE in terms of cross-national comparative studies of student achievement.* Some respondents, especially policy makers, measured quality SE in terms of its rank as rated by the Programme for

International Student Assessment (PISA) the International Association for the Evaluation of Educational Achievement (IEA), the Trends in International Mathematics and Science Study (TIMSS) and the Progress in International Reading Literacy Study (PIRLS), all of which measure the quality of education by comparing students' performance across different countries (Mullis, Martin, Foy, & Arora, 2012).

The view towards appropriate measures for quality SE was identified by the findings of the present study to be varied and conflicting. It is argued in this thesis that bringing all the views together to form a grand design measure could be more useful than using a single measure as the only lens used to judge quality SE experiences in schools. In so doing, the perspectives of different respondents are brought together to define the aspects of quality SE, thus maximising the possibility of assessing all aspects of learning in science. In line with this argument, UNICEF (2000) suggests that to achieve a fair quality measure there is a need to use a variety of information to judge the effects of education services in schools. This recommendation by UNICEF (2007) is important in SE development because the possibility of providing quality education in any education system depends on the ability to appropriately measure it (Hakielimu, 2007; 2008; Osaki, 2000a & Sifuna, 2007).

Evidence from this study reveals that controversies continue to influence how to correctly describe and appropriately judge the quality of SE in Tanzanian JSS. Different measures for quality SE were identified by each category of respondents. For example, while some insisted on measuring the quality SE by looking at education inputs and processes, others wanted educational outcomes to be used as yardsticks for quality SE. The annual report by TEN/MET and Oxfam (2006) adds that variations regarding the concept of quality SE are usually embedded within the countries' policies, educational missions, visions, targets, technology in use, and the composition of groups of stakeholders.

It is crucial to consider that the important concern in selecting the approach for judging the quality of SE is not by focusing on whether or not such practices emphasise inputs, processes, or outcomes as criteria for judging quality of SE; what matters is whether the selected measures consider a variety of information

from different sources in making judgments about the effectiveness of educational practices. To achieve either explicit or implicit goals, an agreement across stakeholders on a single model for measuring quality SE is a huge challenge. However, efforts can be harnessed to get a comprehensive grand design, which could be used to provide a picture of the overall trend of quality SE in Tanzanian JSS. According to Okoh (2003) pragmatism offers a means for encouraging multiple approaches towards what works best rather than limiting the judgment of quality SE to testing or a single measurement; a situation which has the potential to disadvantage the learners and thwart their hopes and expectations for pursuing further science studies.

9.4 Varied Views about Major Descriptors for Quality SE

Some researchers refer to quality education using descriptors such as input, process and output (Torres, 2000; UNESCO, 2004). In the context of this study, however, the question has remained as to whether the terms input, process, and output are adequate descriptors for delineating the concept of quality SE. A prevailing problem among respondents' responses revolved around the inferences being made when these terms were used. As a result, there has been increased difficulty in identifying appropriate descriptors for quality SE. Some writers emphasise a consideration of the context of learning in describing quality education (Tikly & Barret, 2007; Tikly, 2010; UNESCO, 2007), whereas others (Mrutu, Ponera, & Nkumbi, 2005; Pigozzi, 2006; 2006b) demand reflection on the dynamics of stakeholders, culture and technology. Such a difference in views regarding the major descriptors for quality education have brought forward another group of writers including Thomas (2003) and Sifuna (2007) who indicate that there are no universal descriptors for quality education but they have failed to provide valid ways at addressing the measurement of quality education.

The dilemmatic view towards descriptors of quality SE was also evident where various aspects were identified as descriptors for quality SE in Tanzanian JSS. It was evident that aspects such as sufficient funding, the level of technology available, curriculum relevance, clear policy, and availability of teaching and learning materials, relevant pedagogical patterns, availability of material resources, positive learner characteristics, and the availability of teachers were important. However other issues such as culture, context, technological status

and stakeholders' composition were echoed in the findings as important in shaping the definition of quality SE. The details for each of these issues are discussed in the subsections that follow:

9.4.1 Context

The respondents described context in terms of geographic location, language of instruction, religious disposition, national educational standards, public expectations for education, socioeconomic and cultural conditions, public resources available for education, labour market demands, philosophical perspectives governing education in practice and social forces that affect and control the education system. Researchers argue that contextual factors have generally been ignored in education reform initiatives (Tikly & Barret, 2007; Tikly, 2010). According to Mosha (2000), Summra and Rajani (2006), and Kalolo (2010) the development of a quality education system should begin with consideration of the relevance and responsiveness or expected development impact of an education system on society. It was also evident from the findings that respondents were asking for consideration of contextual factors as a step towards doing away with colonial burdens existing in their education system.

9.4.2 Technology

Technology in education is mostly related to a systematic organization of knowledge, tools, and/or activities to assist human in adapting, participating, and utilising the environment sustainably (ITEA, 2000; Wilmarth, 2010). According to Switzer, Callahan, and Quinn (1999), technology resources have not only been able to provide and determine learning, but also have helped in creating conditions that can optimise learning. Levy and Murnane (2005) and URT (2007) show that technology has assumed the role previously occupied by a teacher as a source of knowledge and a vital door opening to the world for the learner to access libraries, interact with other learners and experts, as well as to access a vast array of resources beyond the classroom and textbooks. It was evident in the findings that respondents wanted an extension of learning space beyond the four walls of a classroom, thus transforming technology into a vital component for quality SE. With demands for integration of technology into educational practices being met, the world arguably becomes flexible, open, and able to offer diverse learning environments, for example through an increase in the use of mobile phones and computers in learning. This situation

is described by respondents as providing opportunities for contextual, timed, interactive, and personalised learning; experiences that signify the beginning of another era of a variety of learning descriptors beyond those commonly known.

9.4.3 Culture

The concept of culture as applied in this thesis encompasses among other things the art, literature, lifestyles, value systems, traditions, norms, language as medium of communication, as well as beliefs (Banks, 2008; Bishop & Berryman, 2006). There has been a growing interest and support to recognise culture as an integral part of broader quality education because quality education exists as an outcome of cultural processes and contextual opportunities, which ultimately also determine its status (Bishop & Berryman, 2006; Gay, 2000). The findings suggested that culture shapes an individual's worldview and the way they approached the aspect of quality SE. While acknowledging the role played by other quality SE descriptors, it is necessary to consider the cultural dimension as a descriptor for quality SE because for an education system to excel and perform well in its function of transmitting cultural values there is a need for integration of the cultural dimension in describing the concept of quality SE.

9.4.4 Stakeholders' Characteristics

Stakeholders' characteristics vary, but generally include the socio-economic background of the stakeholder, their place of origin, their cultural background, religious background, educational qualification, and occupation (Campbell & Rozsnyai, 2002). It is the diversity of stakeholders' characteristics that results in multiple views regarding quality SE, as seen from the findings. The stakeholders in SE had varied views about the outcome of schooling and the purposes of learning; a situation that influences the planning, practice and monitoring processes of quality SE. For example, while science alumni wanted their education system to ensure that the economic and cultural values of Tanzania were perpetuated and developed among learners, the government wanted to educate children towards ensuring a stable, productive and powerful nation.

Students, however, regarded quality SE as a vehicle that would enable them to be independent and reward their parents' wisdom and sacrifice in raising them.

Parents wanted their children to have an education for the sake of developing skills that would enable them to leave home and flourish in their chosen paths. Such multiple and varying views suggest the need to consider stakeholders' characteristics as an important aspect to developing and measuring quality SE. The four issues described in the earlier subsections (9.4.1 to 9.4.4) indicate a new focus towards producing a comprehensive definition at quality SE in today's schools. The findings present the need to integrate these descriptors into the commonly known ones. Figure 11 shows how these descriptors can be interconnected to describe the concept of quality SE.

Figure 11 *Factors determining the quality of SE in Tanzanian JSS*

Source: Author

9.5 Varied Goals for Quality SE

Debates about the need for quality SE in the twenty-first century have recently escalated interest in internationally (Goodrum et al, 2001; Tytler, 2007). The variety of goals for quality SE have not only introduced confusion and controversy in SE discourses, but have also raised challenges regarding the targets for quality SE (Malekela, 2000; Mosha, 2000). The findings of this study revealed a wide array of goals for quality SE that were considered as being indicative of quality SE. These are discussed in the subsections that follow.

9.5.1 Winning the Global Competition

As the world enters a new era of technological development and high competition in service delivery among JSS, evidence shows that education sectors are confronted with the challenge of changing old practices and educational procedures to accommodate technological advances and compete globally (Bull et al., 2010; Gluckman, 2011). These new initiatives have raised interests in improving quality SE to match the global competition in resource production and service delivery (Bybee & Fuchs, 2006; Osborne, 2007). The findings of the present study revealed that stakeholders viewed winning the global struggle as an important achievement, one which was only possible through ensuring excellence in education systems and their outputs. Looking at global differences in context, culture, technological development, socio-economic development and so on, one question remains unanswered: How can one be a good competitor, and a global winner for that matter, via provision of quality SE if the concept of quality itself is contextually defined and in most cases not commonly understood? Harmonising different emphases through pragmatism towards what works best in bringing forth good SE outcomes is considered in this study as being an important approach to adapt.

9.5.2 Fulfilling the Stakeholders' Right to Quality SE

Stakeholder satisfaction and fulfilment of the right to a quality education are reasons for improving quality education (Pigozzi, 2006; Tikly & Barrett, 2007). In Tanzania parents and other SE stakeholders were highly conscious of their right to achieve value for money as they invested significantly in their children during their schooling period. Students, on the other hand, wanted schools to fulfil their responsibilities in providing quality SE, which would ensure that students got

their deserved right of quality SE in schools and ensure positive outcomes for the time spent in schools.

9.5.3 Achieving and Maintaining Standards

Achieving and maintaining standards as a global initiative towards achieving quality SE has brought forth another need for a redefinition of how the goal of quality SE can be realised (Van Eijck, & Roth, 2007). The findings of this study also mirror the global need to improve quality SE so as to meet the challenges of developing scientifically literate citizens as well as meeting global market demands. Drawing from the Tanzanian current experiences, the standards for quality SE are locally set and efforts are then organised to meet those standards. This situation suggests that as long as there is a difference in context, culture, and goals for education, it is difficult to have universal and common goals for quality SE.

9.5.4 Increasing the Credibility, Prestige and Status of Education Systems

The findings reveal that one of the major reasons for providing quality SE in Tanzania is achieving consistency with leading practices in the world, by raising the status of educational outputs and the production of the brand value of educational output. The respondents, especially parents, had a feeling that by achieving high quality SE, learners would be guaranteed assurance of employment, a good life, and monetary stability. This opinion is in contrast to the view by policy makers whose emphases are more into developing responsible citizens and meeting the general needs of the public. Such difference in emphasis, has led to directing all efforts to improve the system for the sake of the system itself, a situation which presents another uncertainty as to whether raising the status quo, the image and reputation of the education system, would actually be associated with good SE outcomes.

9.6 The Implications of the Controversies Regarding Quality SE

The analysis of a range of respondents' views about quality SE as discussed earlier reveals a number of influences, including the category of stakeholders involved in the study, the cultural background of these stakeholders, the context in which quality as an educational aspect is described, the technology currently in use, the era under which a specific definition is given and global views on quality SE.

It is evident in the above conceptualisations that stakeholders differ in the way they describe quality SE. This difference could be attributed to their occupations (as policy makers, curriculum developers, and educators), educational exposure, and the era in which such conceptualisations were formed and ultimately shaped their beliefs about quality SE. Similarly to studies conducted by Sifuna (2007), Thomas (2003), and Tikly and Barrett (2007), it was evident in these findings that what is considered quality in one country might be different to that in another country, due to differences in context, culture and stakeholder composition. In a country such as Tanzania, where colonial burdens are still reflected in existing education frameworks, there is a need to review the ways quality SE is conceptualised. This process will not be addressed adequately with a positivistic perspective alone but rather through a pragmatic perspective that can act as a mechanism to harmonise diverse conceptions about the concept across different educational key players. In sum, the findings from this thesis suggest an expansion of the way quality SE is understood by defining it in light of other descriptors (see Figure 12).

Figure 12. *Descriptors for understanding quality SE in Tanzanian JSS*

Figure 12 shows that quality SE in Tanzania may therefore be defined as a function of cultural influence, contextual influence (relevance), the technological status of place and the way the technology is applied in education, stakeholders' standpoints, socio-political will in terms of whether quality education is a priority, and the global view with reference to the so called promising practices. The use of this new focus towards quality SE together with *input - process - output model* by OECD (2003) and Scherens (2002) depicts a changing nature to thinking among stakeholders in producing a strong, quality and relevant SE system.

But again, data reveals that the way quality SE is conceptualised is rapidly evolving over time and is likely to have different emphasis in different nations, education sectors, cultures and among different players in the education system (i.e., students, teachers, policymakers, business communities, and other local actors). The difference in perspectives among these groups, as seen in the afore-outlined stakeholders' conceptualisations, aligns with the persistently elusive nature of the term 'quality education' as propounded by Sallis (2002), its multi-faceted nature by Fraser (1994) and its slippery and value-laden nature by Harvey and Green (1993).

A consensus on quality SE is unlikely to be achieved without pragmatic adaptations to harmonise perspectives towards the common goal of improving quality SE in its particular setting. A pragmatic lens is necessary because with pragmatism, a consensus is more possible, especially with regard to deciding what is important and a worthwhile type of education for the general public. While acknowledging the diverse standpoints of stakeholders towards quality SE, pragmatists such as Dewey (1897) and Sleeper (2001) argue for the need to integrate school experiences with societal challenges and the processes of learning with actual life problems. This is all about building the relevance of education to its society.

In light of the earlier conceptualization about quality SE and the controversies based on its nature, measures and goals, the findings echo a number of contestable foci in improving the quality of SE in Tanzanian JSS. These foci include: quality SE for individual survival, quality SE for individual protection against discrimination and insecurity, quality SE for individual development

(cognitively, psychologically and affectively), quality SE for active participation and empowerment in decision making, quality SE for individual and social promotion (economically, socially, and culturally), and quality SE for satisfaction or meeting individual interests and desires. Given the pragmatic implications of these varied emphases, there is a need for bringing these foci together and be used as a comprehensive model for guiding the emphasis for quality SE in Tanzania. These foci are summarised as the ***S²DP³ model*** for developing quality SE. The model is created by taking the first letter of each quality dimension in Table 18.

Table 18: The elements of “S²DP³ model” for quality SE in Tanzania

Quality dimension	Quality indicator
Survival	<ul style="list-style-type: none"> -Emphasis of skills in demand by the job market and the community at large. -Opportunities for learners to build their own knowledge by combining indigenous and external elements.
Satisfaction	<ul style="list-style-type: none"> -Opportunities for fulfilling the stated or implied needs of the stakeholders and adding up to the customers' satisfaction, meeting or/and even exceeding the stakeholders' requirements and expectations. -Opportunities for satisfying the learners' interests, meeting their desires and providing a conducive environment that nourishes and nurtures learners' passion for science. -Opportunities for achieving the stipulated education aims, goals and requirements of interest groups in education.
Development	<ul style="list-style-type: none"> -Opportunities for students to develop to the fullest potentials in terms of cognitive, emotional, and creative capacities. -Opportunities for developing learners within their professional expectations, preferred professional identities, and person they desire to become in the future. -Emphasis on schools' enhancement and students' empowerment, with students learning competencies and skills required for developing individual identity.
Protection	<ul style="list-style-type: none"> -Assurance of development of learners' attitudes free from discrimination, where all have equal opportunities to develop themselves, their families, and their communities. -Presence of support objectives of peace, social responsibility and security.
Participation	<ul style="list-style-type: none"> -Opportunities for involvement of diverse categories of stakeholders in decision matters related to the nature, structure, processes and the outcomes of their schools' SE. -Opportunities for students to be involved in broad range of work and community activities that affect the quality of their lives and of those around them. -Presence of mutual respect, shared power and authority in matters concerning education.
Promotion	<ul style="list-style-type: none"> -Emphasis of individual and social promotion economically, socially, and culturally as a result of schooling. -Emphasis on students' employability, assurance of good future prospects, and graduates' productivity in the society. -Opportunities for promoting equality and equity, with recognition of the cultural diversity surrounding the education arena.

9.7 Summary

This chapter has presented critical comments about quality SE and the controversies that exist around its meaning, descriptors, measurement, and importance in Tanzanian JSS. In response to the existing controversies, several relationships have been identified as being helpful in addressing such diverse views. These relationships are described in Figure 11 and 12, and Table 18 all of which are the authors' creation. The analyses in these illustrations demonstrate how key descriptors and the emphases for quality SE can be related and theorized. While the suggestion remains important, the position adopted was that science educators and researchers still need to squarely place on the table all the controversies about quality SE for discussion, honour their presence, and plan to solve them using a pragmatic perspective - this is important because this worldview uses a multiplicitous paradigm of dialectic approaches, which would likely help to address the concept of quality SE as effectively as possible.

Using a pragmatic approach it is also possible to accommodate most conceptualisations of quality SE by harmonising their differences and deploying their specific usefulness in presenting a comprehensive, inclusive, flexible and useful model for understanding the concept of quality SE. the combination of approaches to address quality education would provide a better understanding in addressing the concept of quality education. This argument is based on the idea that each view towards quality SE when applied singly has its own limitations, which could be addressed by deploying another approach concurrently.

CHAPTER TEN: DISCUSSION II

BARRIERS AND CHALLENGES TOWARDS PROVISION OF QUALITY SCIENCE EDUCATION IN TANZANIA

10.0 Introduction

Ensuring that JSS students experience quality science education is a goal that Tanzania has looked forward to achieving (URT, 1995). This chapter discusses respondents' views about the reason why this expectation has not been achieved so far. The chapter firstly discusses a variety of perceived barriers, both internal and external, that have impeded the provision of quality SE in Tanzanian JSS. The chapter then identifies the implications of these barriers towards provision of quality SE in JSS.

10.1 Internal Barriers

According to respondents, the internal barriers towards quality SE emanate from the Tanzanian education sector itself (i.e. MoEVT). The findings of this study identified a number of these barriers, including availability of learning support services and facilities (such as science labs and libraries), curricular relevance, sufficiency of teaching and learning resources, the availability of teachers, adequacy of pedagogical approaches, command of English for both teachers and students, relevancy of science content, relevant student learning attributes, effectiveness of assessment procedures, teacher development plans, structural efficiency of the education sector, and effectiveness of collaborative patterns in education. These barriers are discussed in the subsections that follow.

10.1.1 Availability of Learning Support Services and Facilities in JSS

The availability of learning facilities (such as science labs, computer labs and libraries) and learning services (such as the counselling and guidance units) in schools is viewed by Hamilton et al (2010) and Mafumiko (2004) as having an impact on achieving the goal of providing quality SE in schools. The findings from this research revealed that schools lacked learning support services and facilities. Even where the laboratories, libraries, and counselling and guidance units were present, they were usually not fully equipped with attendants and responsible staff and equipment was often obsolete. Mahlaba (2006) argues

that the lack of learning support materials and services not only denied students' the opportunity to develop scientific skills, but lead to loss of interest in science based disciplines.

Saunders (1992) adds that for students to learn science concepts, they need to have experiences that reveal and build upon their current cognitive schemas, as well as providing opportunities to construct their own understanding of concepts through events that challenge preconceived ideas. However, all these are dependent on the availability of learning services and facilities.

The findings also showed that there was a gap between required and available learning support services in Tanzanian JSS, a situation described by respondents as impeding efforts to provide quality SE in schools. The respondents felt that adequate and modern learning support services were necessary for students to develop study skills, as well as important for those students who wanted to enhance their academic experience in science to meet their educational goals for science careers.

10.1.2 Curricular Relevancy

According to Bybee (2010b), Dillon and Redfors (2014), and Hodson (2011), the presence of quality and relevant curriculum strongly supports good educational achievement and educational gains. Evidence from the current Tanzanian science school curriculum materials (such as syllabi, schedules, exams, marking systems, and textbooks) showed that there was a high level of content abstraction, a situation which was felt by respondents as contributing to learners inability to connect curriculum materials to their daily experiences and lives. Similar to the observation by Osborne and Dillon (2008), most of the curricular materials in this study were characterised by textbook-driven knowledge and inadequate SE programmes, experiences which were identified by teachers as leading to learners' inability to actively participate in learning. Teachers also felt that the science syllabi were overloaded with too many topics per grade level, a situation identified as hampering student understanding and skill development in science.

Despite the clear intentions of the Tanzanian government to have a more relevant and useful curriculum as stated in the reports by MOEC (2004b), MoEVT (2008) and URT, 2010a) it was consistently noticed among

respondents, except students and parents, that the science curricular materials had a number of problems including:

1. The failure to provide JSS students with knowledge, skills and competencies that would be useful to them when they leave school; consequently the SE being taught in schools was not useful in their daily life, and many students did not achieve sufficient understanding of it to be able to contribute to scientific debates;
2. Too much emphasis on theoretical aspects of science and not enough examples of applications of science to students' life. This situation contributes to a high level of content abstraction, content overload, and the failure of science being easily connected to the learners' daily lives;
3. Absence of opportunities to nurture students' abilities, including investigative, problem solving, and critical thinking skills. Consequently students were failing to develop self-driven creativity, curiosity, and success in learning;
4. Irrelevance of curricular materials such as science textbooks whose contents are usually adopted from foreign science textbooks with no emphasis on local science related contextual or environmental problems;
5. Cultural and context irresponsive of the science curricular whereby the structure and its focus do not reflecting the: demands of diverse abilities of the Tanzanian learners; learners' needs and daily experiences; and the needs requirements of the twenty first century which is governed by knowledge-based economy;
6. Poor implementation of the competence-based curriculum whereby although competence based syllabi was endorsed for use in schools as an outcome of the current curricular review, Tanzania still uses the content-based syllabi which still contain topics instead of tasks defined by competence descriptors and indicators;
7. Limited avenue for the majority of SE stakeholders to have their voices, needs and expectations addressed in the curriculum;
8. Mismatching between the three types of science curricular exemplified by disconnectedness between intended, implemented and attained curriculum.

Chonjo et al (1996), Knamiller, Osaki and Kuongal (1995), Marsh and Willis (2003), Meena (2009), and Ottevanger, Osaki and Van den Akker (2005), consistently argue about the existence of poor and irrelevant science curriculum as impeding efforts to provide quality SE experiences in schools. A similar finding is noted in this research, whereby most science alumni revealed other curricular challenges, including content and textbook-driven curricular experiences and irrelevant curriculum emphases, all of which were based on what learners cannot do rather than what they can do.

In respondents' view, the science curriculum in practice was not responsive to, or connected with, students' contextual science knowledge. This situation calls for curricular reform in schools leading to a contextualised science curriculum that would use Tanzanian real-life examples. This approach is supported by pragmatists who recommend that the curriculum should be based on the principle of utility (Fontrodona, 2002; Goodman, 2005; Singh, 2007). This principle states that only activities, experiences and courses that are useful to the present needs of the learners and their future expectations need to be included in the curriculum.

The science curriculum was also said to be confronted by the challenge of a knowledge explosion in scientific fields. This belief was evident from both the respondents' voices and the documents analysed. For example, in the JSS science syllabi, students were exposed to around ten compulsory and five optional subjects per grade level. This resulted in the exposure of learners to too many subjects per grade level, a situation suggested as having influence on students' understanding and knowledge development. While acknowledging the necessity of curricular flexibility, it can be argued that having too many subjects per grade level is not productive for students, and what to include in the curriculum should be carefully established to avoid overloading. Studies by Bull et al (2010), Marsh and Willis (2003), and Tytler (2007) all suggest that the questions about what to learn, to what scope, for whom, when and how, are necessary questions to be answered with care so that the education experience provided matches the expectations of society. It is argued in this chapter that there is a need for a curriculum that would be: able to connect classrooms experience to learners daily life; useful for the present and future life of a learner; enables learners to become responsible citizens; equipped to match

the needs and daily experiences of the learner; and that presents a full range of career options that learners can pursue in the future.

10.1.3 Sufficiency of Teaching and Learning Resources

Sufficiency of teaching and learning resources such as visual, audio-visual, textual and non-textual materials were identified by respondents as being vital components for providing quality SE in Tanzanian JSS. As contended by Kola (2003) and Kalolo (2010), resource availability in SE plays an important role of determining the degree to which a learner becomes informed and is assisted in learning. While many nations around the world have embraced the need to improve teaching and learning resources in SE, in this study, respondents identified the problem of insufficiency of teaching and learning resources in Tanzanian schools.

Five major issues were raised regarding quality learning resources. These were insufficiency, irrelevance, context irresponsiveness, inaccessibility, and obsolescence of resources. While context irresponsiveness, obsolescence and irrelevance of learning resources were identified as being a failure of the responsible departments to keep up to date inventories, the problems of insufficiency and inaccessibility of resources were related to the failure of responsible departments to provide a variety of ways of learning science.

In light of the existing learning resource predicaments, there appears to be a need to incorporate a number of alternative pathways by which SE can be learnt into school curricular. These could include the use of other learning facilities in providing contextual learning experiences outside the classroom, and/or making use of the human and physical resources available in the local environment.

10.1.4 Availability of Teachers

Similarly to the findings of this study, international literature on quality science education identified the availability of committed, qualified and experienced science teachers as among the significant factors influencing the quality teaching and the learning of science (Windschitl, 2009; World Bank, 2007). The findings of this study indicated that there is a persistent shortage of well-trained, qualified, career-committed science teachers in Tanzania. The reasons for such a shortage were identified by respondents as:

1. A tendency of many students from JSS to give up science due to the lack of qualified educators who could competently teach science, a situation which has emerged as a result of fewer students in today's science classrooms and a loss of belief among youth (prospective teachers) that science education can provide a good future;
2. Failure to recruit and retain high calibre science teachers, together with the excessive absenteeism among science teachers;
3. Losses of a significant number of qualified science teachers due to more favourable employment conditions in countries such as Botswana and Namibia, where teachers are better paid and able to expect a better life. Respondents also noted rates of infection of HIV/AIDS, which has been wiping out the new generation in the education sector, including SE teachers;
4. The poor working environment of science teachers, amplified by low teacher salaries, a situation which led to most teachers taking up a secondary employment to make ends meet.

The findings also reveal a situation whereby the lack of science teachers limited the number of students who could study science. This in turn leads to a shortage of science graduates and subsequently to shortages of science teachers. This finding finds agreement with Kitta (2004) and Osaki (2004a), who attribute the reason why young, talented and energetic people are losing interest to becoming teachers; teachers are undervalued, underappreciated, and paid a low salary compared to other careers.

Furthermore teachers felt that the Tanzanian Teachers' Union did not have a good partnership with the Ministry of Education and Vocation Training. The partnership was described by teachers as having a negative influence on efforts towards providing quality SE in JSS (URT, 2001a). It was evident from science alumni and parents that the government, through the MoEVT, had been in conflict with teachers regarding their working conditions. This conflict has created fear among teachers about the viability of their livelihoods. Teachers themselves complained about the lack of respect given to them especially as they believed they were key players for educating future generations. Such teacher related situations; including abandonment, underpayment, and poor

care were identified by most teachers as closing down their motivation to stay in the teaching profession.

10.1.5 Adequacy of Pedagogical Approaches used by Teachers

The quality and adequacy of pedagogical approaches (i.e. the way science is taught and learnt) used by teachers has a direct impact on quality science learning in schools (Goodrum et al., 2001; Osaki, 2000a; SACMEQ, 2005). Quality pedagogy was described by most teachers to be determined by a number of factors including; subject matter knowledge, classroom management techniques, class size, and the culture which determined the activity of conversations in the classrooms. This study found that Tanzanian, JSS faced the problem of inadequate and poor teaching approaches that were discouraging learners from developing interests in science. The consistent response from students and science alumni was that a limited range of pedagogical strategies were used; mostly science pedagogy was teacher-directed. This led to students assuming the role of passive learners with limited power to select and use effective learning strategies to manage their own learning. The findings also revealed a number of other pedagogical challenges including:

1. Limited teaching approaches that encourage problem solving;
2. Inadequate instructional time and lack of remedial classes to help students with learning difficulties;
3. Lack of opportunity for students to interact with content, a situation which contributes to learners' disengagement in science;
4. Failure of teachers to acknowledge students' socio-cultural backgrounds, a condition which had further contributed to student disconnection from science learning.

Despite the developments in global science pedagogy, the practices outlined by the Tanzanian science syllabi indicated traditional teacher centred lecture methods, in which teachers were the main source of knowledge while students assumed a passive role, reproducing knowledge gained through memorisation (MOEC, 2001; 2005). Such a traditional pedagogical outlook was consistent in all analysed science subjects in which there was a dominance of what Freire (2000) called the banking approach to education. This practice is manifested in

the use of lecture methods, chalk-and-talk, and the giving of instructions for learners to follow, a process which promotes recalling factual information rather than developing skills.

Goodrum et al (2001) and Osborne and Dillon (2008) confirm the dominance of traditional pedagogical focus in most science classrooms internationally, as a consequence of teachers having to cover an overcrowded science curriculum within a specified timeframe to ensure that students are prepared for the norm-referenced assessments.

From the pragmatic standpoint, passive and static methods of teaching are considered to limit the learner, cutting them off from connecting what they learn with their own activities and experiences (Singh, 2007). Pragmatists oppose textbook centred pedagogies, because such pedagogies create an environment where there is little interaction between the teacher, the subject matter, and the students. A pragmatic approach suggests a need to shift from traditional pedagogies to inquiry based methods which are likely to increase the learners' interests and engagement in science.

Similarly, the Education Review Office in New Zealand (2005) argues for the use of a variety of pedagogical approaches in science teaching. ERO states that identifying and employing a variety of effective pedagogical approaches in science learning is likely to contribute to a high level of student engagement in learning, as well as increasing achievements. Pedagogical approaches that could be adapted include teaching for understanding (National Research Council, 1996), an authentic pedagogy (Newmann & Associates, 1996), learner centred teaching (Chung & Walsh, 2000; JICA, 2009), and transformative and inquiry based teaching (Felder & Brent, 2009).

According to O'Sullivan (2006) it is important to understand, acknowledge, and build upon students' pre-existing abilities and experiences in science, while concurrently tailoring the instruction to address the unique challenges faced in the learning process. At the same time there is a need to focus on being responsive to students learning needs and expectations. Duit and Treagust (2003) argue that students would excel in science if they were taught problem-solving skills and if instruction was culturally appropriate. This would help those grounded in their traditional knowledge to clarify modern science concepts, a

vital aspect which is neglected by most Tanzanian science teachers in their teaching practices (Hakielimu, 2008; Hamilton et al., 210).

10.1.6 Command of English (as a Language of Instruction) for both Teachers and Students

Teachers and students' fluency and competence in the language of instruction plays a great role in developing understanding of the subject matter and is therefore an important factor for quality education (McKinley & Keegan, 2008; Vuzo, 2005). Tanzania is a bilingual country where both English and Kiswahili are used as languages of instruction in secondary and primary schools respectively. While admitting the importance of Kiswahili in communication it is also acknowledged that Tanzanians are part of the global family and therefore they cannot ignore English, which is the leading academic language of the world in commercial transactions and widely spoken language internationally (Qorro, 2006).

However, most of respondents with the notable exception of parents, felt that using the English language as a medium of instruction was another impediment to quality learning in science. The respondents, especially science alumni and Heads of schools, noted that students and teachers were struggling to make sense of the subject matter because of their poor English. According to Osaki (2005) and Qorro (2004) the use of English as a language of instruction in SE has for a long time frustrated students in their learning and knowledge acquisition. Contrary to the comments by parents who viewed English as being an important indicator for quality SE, students complained that using English as a medium of instruction for science contributed to their failure to comprehend what was written or taught and, consequently leaving them with no option besides resorting to memorisation. The respondents also confirmed that together with other factors, the use of English language was responsible for not only limiting students' ability to easily understand the science subject matter but also contributed to the alienation of students from their own Tanzanian languages.

The general analysis of the findings about the language of instruction showed that poor understanding of English among teachers and students had resulted in a number of negative impacts in Tanzanian JSS. These included:

1. Limiting most science classrooms sessions to providing exercises and teachers explaining the fixed body of knowledge to students;
2. Insensitivity to a sociolinguistic reality in Tanzania, whereby more than 120 tribal languages are spoken by students as their first languages. Consequently, students are alienated from their own language;
3. Banning the use of the Swahili language at all levels of secondary education, a practice which leads to denial of an opportunity for learners to competently interact with and benefit from the science content using the language they are conversant with, and failure to support learners in (who are non-English language learners) understanding of what is being taught in the science classrooms.

These findings are aligned with those of Vuzo (2005), who found that the use of English as the SE language of instruction of non-western countries frustrates the efforts of educators and researchers to improve the delivery of quality education. The findings of this study are congruent with the views by Qorro (2006) and Maddock (1981) that have identified that the use of English has led to most learners failing to comprehend what is written or taught.

According to Vuzo (2005) and Roy-Campbell and Qorro (1997), the use of a foreign language as the language of instruction (English in this case) leads to a point where instead of producing critical thinkers, well-prepared learners, and a capable workforce, the system produces a generation of students who have spent countless hours memorising words and phrases which they neither understand nor can apply.

10.1.7 Relevancy of Science Content

The learning of relevant science content in schools is a vital component for providing a strong base for informed decision making, enhancing interest in science careers, developing science interest and a desire to stay longer in science careers (Rose, 2006; Schreiner & Sjøberg 2004). The lack of relevance of the science content taught in Tanzanian JSS is described by science alumni, students, and parents as being the barriers for quality learning and developing interest in the subject. Of concern was the tendency to use books and other learning materials in Tanzanian JSS that were culturally intended for schools in Europe and North America. This tendency not only

makes science seem like an alien subject, but also it limits learners from connecting science to their daily lives.

According to Gay (2000) and Schreiner and Sjøberg (2004), there is a need to connect SE to the lives of students to enable learners to see the relevance of what they are learning. While this view is consistent with the pragmatic viewpoint, which emphasises building a link between what is learnt in the classroom and the students' daily experiences, the same view contradicts the approach by TIMSS and PISA whose targets have been translated as universalisation, homogenisation or globalisation of science content as a strategy to improve the science literacy. Though the ideas of PISA and TIMSS have merit, such approaches seem to have masked the need to address the contextual issues in Tanzania, and also learners' diverse learning needs. This practice has resulted in the production of irrelevant science content in most schools located in the non-western world. The studies by Ninnes and Burnett (2001) and Ryan (2008) challenge the tendency to present modern science content to students as an established body of facts and unchallenged knowledge, arguing that to do so again limit the opportunity for learners to question its viability.

Analysis of curriculum materials revealed that science concepts and nature content that had to be learned by students were overwhelmingly prescriptive, abstract, and irrelevant to learners' daily lives. Most of the science content was not tied together strongly by bigger unifying ideas or concepts. This problem was common across all science subjects' syllabi; the applications of science content were consistently presented as examples and not as the essence of the science learning itself.

The poor science content was described by most of respondents as having emanated from too much emphasis on the theoretical aspects of science with its content being packaged and presented to students in ways that were not underpinned by learning theory and did not take into account students' ages, interests and abilities. Notably the situation was exemplified by:

1. Access to science knowledge being limited to textbooks, with little consideration of the relevance of applications of science in students' everyday situations;

2. The use of culturally inappropriate and un-contextualised science textbooks and other learning resources offered by the western publishers which have little consideration of the local science, contextual challenges and needs.

As a vital aspect of quality SE, the relevance of science content has been a major topic in most science debates with a central issue being the need to develop science content that would match the students' needs and expectations (Hakielimu, 2007; MoEC, 2004a; Osaki, 2000b). The current global pressure towards relevance of SE content to students' lives can also be exemplified by the real situation of science content as revealed in the findings of this study. For instance, the majority of students and the science alumni complained about science content being irrelevant to the students' everyday world, and called for a reorganization of science content to make it relevant to learners' daily lives. This process is likely to enable learners to perceive science as something they encounter in their everyday activities at school or at home.

10.1.8 Students Learning Characteristics

Students' learning characteristics play a significant role in achieving the goal of delivering quality SE in Tanzanian schools (Fletcher, 2003; Kalolo and Kafanabo, 2012; OECD-GSF, 2006). Most respondents, except students, mentioned that students' learning characteristics were one of the barriers to the delivery of quality SE. They identified students' learning characteristics as including students' unwillingness to learn, poor SE background knowledge, poor proficiency in the instructional language, lack of motivation, family stress, lack of interest in the subjects, lack of perseverance with the challenges specific to science learning, a limited desire to gain new knowledge or achieve new competencies, and negative attitudes towards science studies. As such, for learning to be effective there is a need for all internal and external students' characteristics to be positively operating.

Results from the teachers' questionnaire showed broad agreement on students' characteristics as important factors influencing the provision of quality SE. These included:

1. Increasing loss of interest towards science studies among learners. This is evidenced by teachers who revealed that most JSS students have

been showing an apathetic attitude towards science, with preferences to forgo science after secondary school education for other lucrative subjects, for example, accounting, political science, or law;

2. Persistent dependency on teachers rather than developing an independent learning (owning their own learning);
3. Lack of self-enthusiasm to learn.

The threat described by the findings is the emergence of a situation in which a lot of JSS students who are currently taking science do not have much hope in continuing with science as their future careers. The findings revealed that it is not those students that have interest in science that continue with it but rather those that find themselves studying science do so because they could not secure admission into other, more lucrative courses, such as law, accounting, banking, or finance. This situation calls for a need to attract young learners to science by making science subjects more interesting and relevant to students' future lives. Dawson (2000) and Kalolo and Kafanabo (2012) support the idea that students' loss of interest and engagement in science requires immediate attention if the science workforce gap in the near future is to be addressed. In sum, for learning to be effective, ability, interest, language proficiency, willingness to learn and retention of students in science are essential areas to be addressed in producing a scientifically capable workforce for Tanzania.

10.1.9 Effectiveness of Assessment Procedures

Quality of education is described by the ability of assessment procedures to measure and guide the school practice towards excellent educational achievements (Corrigan, Gunstone & Jones, 2013; Davis & Martin, 2008; Rennie & Parker, 2000). While considerable initiatives have been undertaken to improve assessment procedures in Tanzanian SE, evidence from this study indicates that there is little effort invested in developing authentic, reliable, valid, fair, dependable, and engaging assessment procedures. This view is supported by the evidence from NECTA's annual report, which indicates that the proportion of students passing the JSS leaving examinations has been sharply declining over recent years. This is also exemplified by the MoEVT's report which shows that for the past 5 years, the percentage of candidates scoring Division 1 and 2 in the National Form 4 examinations have decreased from 12% in 2005 to 6% in 2009, with science subjects indicating a much worse situation

(NECTA, 2010). A similar report by the NECTA (2011) shows that over 50% of the Form 4 candidates who sat for the 2010 Certificate of Secondary Education Examination received Division 0; meaning they failed the examination.

Findings from this study reveal that assessment procedures have a number of problems including:

1. Disconnectedness of assessment practices from curricular demands, learning needs and expectations, meaning they fail to serve as stepping stones to higher levels of education;
2. Emergence of high-stakes assessment needs. The situation which has reduced: examinations to completely paper-pencil tests; teachers into administrators of high-stakes testing of pupils' achievements and gains; transformed teacher autonomy over their students' expectations and achievements in learning;
3. Emergence of examination guided modes of teaching. This mode of teaching places more weight on teaching knowledge (content, facts, and principles) that is likely to be asked in final exams. As a result, the learning process has been fragmented and reduced into a process of memorising chunks of facts that leads teachers into pedagogies that emphasise rote learning;
4. Invalidity of assessment tools, visible in the tendency of national science examinations to measure what students have never learned. This results in a failure to adequately measure a full range of students' competencies, skills, knowledge and attitudes.

As noted, the annual report by NECTA (2011) shows that over 50% of Form 4 candidates who sat for the 2010 Certificate of Secondary Education Examination achieved Division 0. This is an extension of a trend that has been consistent for the past five years. According to Fensham and Rennie (2013), Rennie and Parker (2000), and Uwezo (2010), ineffective assessment procedures have a significant impact on student learning as they are deemed to promote inadequate student learning, a reduced interest in science, increased dropouts in science options in schools, the production of incompetent graduates, and a general failure to meet the learning desires of most learners.

Similarly, Chonjo et al. (1996) and Hamilton et al. (2010) attribute the problems related to assessment procedures as being a result of: lack of clarity of purpose for assessment; inadequate consideration of the population to be assessed; lack of consideration of what ought to be assessed and how is to be assessed, and lack of clarity to how assessment results are to be reported and utilised. As a result of these situations SE has become an undesirable course of study.

Science alumni and parents believed that at present, schools were not performing the role of being centres for knowledge and skill acquisition, but rather were places that trained students to pass examinations. These findings are in agreement with MOEC (1999), and Hamilton, Mahera, Mateng'e and Machumu (2010), all of whom argued that too much emphasis on testing distracts teachers away from supporting students in developing the necessary skills and knowledge to become life-long learners.

Assessment related problems have been identified as limiting factors towards improving the quality of SE in schools (Hamilton et al 2010; NECTA, 2010; Osaki, 2004a). Vendlinski, Nagashima, and Herman (2007) believe that placing too much value on paper qualifications in Tanzanian society is causing more harm than good to the education sector, arguing that what matters in such practices is not what can be done by the individual (their know-how) but the type of certificates possessed by the individual and to whom such an individual is connected (their know-who). Consequently, the acquisition of good certificates has become a tool for social promotion and a guarantee for a secure future, a condition which leaves students with no option but to go searching for good certificates for securing employment - at the expense of productivity.

The issue of reducing the JSS to "certificate shops" is described in literature as having its roots in the colonial system of education, where examinations were used to judge intelligence, as promotion criteria and as qualifications for employment (Komba, 2006; Sumra & Rajani, 2006). Such an over-emphasis on examinations has led to graduates seeking certificate qualifications at any cost.

10.1.10 Adequacy of Teacher Recruitment, Development and Retention

Improving teacher recruitment, development, and retention processes in education was another important factor respondents cited as essential to

ensuring a strong teacher workforce. However, respondents identified that this was constrained by several teacher related factors including:

1. *Low grades for recruiting the prospective teachers.* Respondents felt low expectations was compromising the quality of teachers produced and authenticity of their qualifications because most of them did not have requisite knowledge about the subject matter;
2. *Inadequate time for teacher training in both diploma and degree qualification in teaching.* This situation was described by the respondents as affecting the competence of the teachers produced;
3. *Absence of teacher development programmes for both pre and in-service science teachers.* This situation was described by respondents as leading to limited knowledge of new pedagogical developments in science among teachers;
4. *Poor teacher retention strategies for both pre and in-service science teachers.* A lack of motivation, incentives, and adequate salaries among science has led to the loss of a lot of teachers, who opted to move into other, more lucrative professions;
5. *Turning the teaching profession into an all-comers' occupation.* Respondents identified this situation as negatively impacting the moral behaviour in teaching, the respect accorded to teaching and the quality of the teaching workforce.

Documents revealed a situation whereby individuals who had failed in secondary schools or did not meet the minimum entry qualifications to tertiary education were accepted as candidates to train as science teachers (MOEC, 2000; MoEVT, 2009a; URT, 2001a). Darling-Harmond (2000c), Kitta, (2004) argued that it was unfortunate that in schools some teachers teach courses they were not trained to teach; a situation which appeared to affect student learning and achievement.

In light of these practices, it can be argued that for quality SE in schools to be achieved, several aspects of teacher professional development frameworks need to be readdressed. Such aspects include recruitment processes, development, retention, and monitoring processes.

Windschitl (2009) argues that it is important to have a well-planned vision for developing a SE workforce for the nation to meet its competent manpower requirements, and suggests a reduction of dependence on foreign experts to solve context-specific educational needs. For the country to have a strong education system in place, a huge capital investment in people, systems, and facilities is required (Komba & Nkumbi, 2008). Most respondents in this study believed that there were inadequate teacher professional development programmes in which teachers could attend seminars, conferences and workshops during vacations so as to update their knowledge. In such a situation Loughran, Mulhall, and Berry (2004) emphasise the need for on-going professional development of science teachers' pedagogical content knowledge. Teachers and science alumni in particular, argued the need to develop a qualified and competent science workforce so as to solve the science professional shortage, especially in areas where they were of high demand. This view is similar to opinions by Hashweh (2013) and Burke, Schuck, Aubusson, Buchanan, Louviere, and Prescott (2013), who argue for a need to focus on the issues of recruitment of beginning teachers, and development and retention of in-service science teachers. This goal is pertinent in meeting the Tanzanian Millennium Development Vision of 2025, which calls for quality education as an outcome of ensuring the presence of quality teachers.

Mtika (2008) insists that for educational achievements to be improved there is a need to refocus science teaching and teachers' development practices. This would mean that quality teacher concepts must be defined beyond mere possession of the minimum acceptable teaching qualification. Encouraging graduates into taking higher qualifications at masters' level in science related subjects would be a desirable. While Okeke (2004) considers a focus on skill and professional development as being important today's teachers, Komba, and Nkumbi (2008) believe that it is also important to consider what it takes to produce good teachers.

10.1.11 Administrative Efficiency of Education Sector

Educational efficiency is described in the literature to be an outcome of good and efficient administration within the education sector (Downes, 2005; Scheerens, 2000). Despite the need to have a good and efficient administrative structure, respondents in this study believed that Tanzanian education matters

were being dominated by organised interest groups, such as corrupt education bureaucracies, while parents, individual teachers, and students were being excluded from discussions about their schools' outcomes. The respondents expressed their concern about the limited involvement of stakeholders in educational decision-making, and felt that educational decision making was being made by those who masqueraded themselves as advocates for the well-being of learners when in fact they are not different from those who put self – interest before quality SE. Komba and Nkumbi (2008), and MOEC (2009b) argue that too much power in the hands of a few individuals potentially creates a loophole for these individuals to champion inappropriate agendas into the education sector, which is contrary to the ambition of improving the power relations among educational stakeholders, opening access, and thus ensuring quality SE attuned to stakeholder needs.

Data also reveals another problem regarding the limited distribution of authority within the education policymaking sector, which appeared to be composed of only few ministry officials who were exceptional in that they had a final say in all matters relating to advocating what to teach and learn and how to do it (MoEVT, 2009a). While acknowledging that it is important to have a co-ordinating team for education matters, it is also essential to have all stakeholders involved in education issues and decisions. Improvements can be made by closely monitoring SE progress, avoidance of interferences by individuals and interests groups that have infiltrated the system, and empowering all key SE stakeholders to have a say on matters related to the education provided.

10.1.12 Effectiveness of Collaborative Patterns in Education

According to Darling-Hammond (2007), collaborative patterns in education are necessary prerequisites and powerful aspects for resolving quality issues emanating from the day-to-day administration of educational institutions. Marion and Gonzales (2013), Smith and Piele (1989) and Darling-Hammond (2007) stress the need for the collaborative patterns in education. In particular they emphasise the need for leadership to ensure communication with their teams, and to encourage broader input, and sharing of power in decision making.

Respondents identified the need for leadership to have vision and to be committed to building and maintaining smooth interactions among the

individuals in the organisation, as well as the ability to meet societal expectations and help students to meet their career dreams in science. Leadership, in this view, is about sense making and sense giving rather than dictating, and in fact is a collective phenomenon (Marion & Gonzales, 2013). Respondents believed that schools were staffed with individuals without a vision for improving science learning experiences in their schools. Science alumni and parents felt this was contributing to the slowing down of the efforts to provide quality SE in schools.

Another aspect noted by respondents was a lack of communication between various groups in education. For example; the disconnectedness between science teachers and teachers of other disciplines within a school, disconnect between the MoEVT departments, and between schools and parents. Decision-making was in the hands of a small minority, and the respondents felt that they were the silenced majority. In their view, a top down approach dominated the SE administration, a practice they held responsible for a decrease in accountability, ownership and fulfilment of responsibility in education.

With changing needs in Tanzanian education and the increasing number of schools, it is arguably imperative to have effective educational collaborations for effective, timely and rapid improvements in transformations in SE. Bybee and Fuchs (2006), and Bybee (2010a) argue that effective collaborative patterns bring educational leaders, managers and other stakeholders together in a forum of openness, communication and increased trust and accountability. Unfortunately, this was not the experience of the respondents of this research. Respondents felt that schools were hampered by ineffectual educational managers and leaders. In their view, schools needed educational leaders and managers who had the ability to nurture promising practices in learning, and the ability to live up to the expectations of the stakeholders in providing quality SE in Tanzanian JSS.

10.2 External Barriers

External barriers in SE originate from outside the education sector and have a direct impact on how SE is enacted in JSS. These include such things as government support, community support, the effectiveness of strategies and policies for moving towards quality SE, and the prevalence of myths around

quality SE. The details of these themes are discussed in the sub sections that follow.

10.2.1 Government Support

Government support in terms of funding and its willingness to invest in SE is considered to be at the heart of any quality education, SE in this case (Osaki et al 2004; Rajani & Sumra, 2003). Despite the necessity of a governmental role in supporting SE, the findings of this study indicated a lack of government commitment, even to the point of negligence or unwillingness, toward developing quality SE in schools. Heads of schools and teachers felt that funding for improving SE in schools was inadequate, unreliable, and insufficient and the commitment was mediocre. Hamilton et al (2010) and Hakielimu (2007) argue that it is important to have adequate government funding support in education because when education is not adequately funded, its foundation is likely to become weak and the country's commitment to train Tanzanian scientists of the twenty first century becomes difficult to achieve. The consequence of this lack of funding would negatively create inadequate and weak foundations for the SE system and impact those students wishing to pursue science related subjects in the future.

The annual budgetary report by Mkulo (2011) showed that there has been a consistent increase in budgetary allocation in Tanzanian education. For example, the budget allocated for education sector in Tanzania has tripled over the last thirteen years from 15.3% of total budget in 1995/96, to 20% in 2011/12 placing it among the highest budgetary allocations in sub-Saharan Africa (URT, 2010b). However, the science alumni argued that though there has been an increase in budgetary allocation in education, very little has been specifically allocated for the development of SE. For them such an increase has brought no change in the quality of SE in schools apart from increasing enrolments. It would have been expected that if schools only needed more money to improve, then with an increase in spending, students' achievements would have improved, and they have not. It can be argued that though money is important, it is not everything in guaranteeing the provision of quality SE in schools, partly because the increasing number of schools and students can inevitably put a greater strain on the funding provided.

The findings revealed another notable problem of persistent ineffective spending of the money allocated for SE development. Rajani and Sumra (2003) argue that it is not possible to have better education outcomes when there is misuse of funds. Given such insights it is important to understand that without stronger management of funds, and concerted efforts for making sure that such funds are effectively utilised and monitored, there is no reason to think that the next increase in budgetary allocation in education will improve the situation in schools. This is to say, it is not enough to increase funds for improvement of quality SE in schools without making concerted efforts to make sure that such funds are properly monitored and channelled into procuring the required outcomes of quality SE in schools. Given the view of Heads of schools and teachers who consider that nothing could be possible in schools if there was not enough monetary investment, an establishment of realistic financial frameworks would be helpful in guiding all educational investments to focus only on those inputs that are known to have a strong positive impact on learning.

10.2.2 Community Support for Students' Learning

Improving quality SE in schools is the joint responsibility of the government and the community through effective partnership (Kalolo, 2010; Muskin, 1999; Roth & Lee, 2004), but despite the importance of this partnership in developing a strong educational system, the findings of this study revealed a lack of support from the community in educational matters. For example most parents appeared not to be involved in what went on in the local schools apart from paying the school fees for their children. With such poor partnership between schools and the community, the planning and implementation of school SE projects remain a challenge. Clarke (1983) argued that it is important to have a good school/community relationships because parental involvement in children's education creates the possibility of enhancing the children's' cognitive development and performance. These relationships do not exist in Tanzania.

Science alumni and teachers felt that there was a deficient home supervision and the lack of parental input in students' learning. This view is supported by UNICEF (2000), who argues that parental care for children and home supervision for their learning has become an issue in most homes. Findings revealed a practice where most parents had abandoned their primary responsibilities of raising their children in the way they would want them to be,

by entrusting such vital responsibilities to the school. Most parents believed that they had to earn and support their families and in so doing the responsibility of their children's education was entirely left in the hands of the schools, a view they felt was justified because they had paid the school fees. Consequently, schools are forced into putting in more efforts to manage the students' behaviour at the expense of the delivery of quality education (Uwezo, 2010).

10.2.3 Effectiveness of Strategies towards Quality SE

As a response to improve the quality of education and access in JSS, the Tanzania government adopted a quantitative increase of JSSs where each ward was instructed to build at least one secondary school. Through the vision of the Government's Primary Education Development Plan (PEDP) and Secondary Education Development Plan (SEDP) in the 2000s, more schools were built and enrolment numbers significantly increased. While this idea was meant to help all Standard 7 leavers to have the opportunity for ordinary secondary education, most respondents argued that such a process was a major contributing factor towards the decline of quality of SE. Hakielimu (2008) supports the idea that an increase of schools in Tanzania has been perceived by most stakeholders as detrimental to the provision of quality education, because it places considerable strain on an already weak education system and also leads to overcrowded classrooms. Consequently, the JSS leavers have academic abilities that do not meet the community expectations.

Unlike the PEDP's and SEDP's aim of showing a commitment to improve the educational quality, the Government's aim was largely focused on enrolling more children in schools with little emphasis on recruiting more teachers (URT, 2010a). Respondents also felt that the learning experiences that JSS students were experiencing were sub-standard due to allocation of more funds for increasing enrolments of children in schools. Tikly and Barrett (2007) argue that the mere increase in access to education, while necessary, does not guarantee quality education. In this regard the shift needs to be from quantity to quality-based visions in improving education, particularly SE in this case.

Another problematic strategy that the Tanzanian government adapted in the period between 2005-2010 included the issue of decentralisation (in form of devolution) in the education sector, which was adopted for fostering a greater

student and teacher motivation, parent participation, curriculum adaptation and community contribution (Hakielimu, 2007). Most respondents believed that the decentralisation process had considerably slowed the development of SE in the country, due to a lack of clarity about power and authority among the educational key players. A review process to redefine the decentralisation process would be useful in specifying roles and rebalancing the power-sharing between the centre setting policy and the periphery carrying the implementation of various educational processes.

10.2.4 Effectiveness of Educational Policy

Effectiveness of educational policies in education requires good alignment with educational targets and contextual educational challenges (Clare & Matt, 2014; Chonjo & Welford, 2001; Fensham, 2009; Osaki & Tilya, 2004c). Contrary to this view, the findings of this study revealed that the current Tanzanian education policy was seen as ineffective; and that its objectives had not been realized for seventeen years since its inception. Most respondents felt that SE policy in Tanzania lacked success in improving the quality of SE due to a number of factors including: Absence of political will and focused improvement of SE, unrealistic and often confusing goals surrounded by political motives, fragmentation in implementing policy recommendations, and inadequate funding. The politicising of educational policy is identified in literature as the reason behind the failure of most African education systems (including Tanzania), both in realising appropriate educational outcomes, and the failure to successfully translate educational objectives into expected educational outcomes (Fensham, 2009; Weaver, 2011).

In spite of several national SE programmes, and structural reforms launched at different times, promised positive impacts have not occurred. This situation raised some concerns among SE stakeholders who appeared to start questioning the authenticity of the educational policy in practice by searching for reasons why their educational system had not been successful in answering the existing educational challenges. This finding is similar to the observation by Sumra and Rajani (2006), who suggest that the existing Tanzanian education policy lacks two necessary qualities: attainability and clarity of goals.

While elsewhere in the world, policies are clear and the development processes are highly driven by science and technological inventions based on such policies, the respondents from this study identified that the Tanzanian SE was being confronted by four operational problems of educational policy in practice including: The celebration of the “Bora Elimu” slogan (Just Education) rather than “Elimu Bora” (Quality Education); too much focus on quantitative rather than qualitative aspects of SE; the failure to create an avenue for all key education stakeholders to participate in education matters; the visions and focus of SE being not developed from common beliefs and values of the public for the sake, thus creating disharmony of interests with all involved in the process of implementation, and inefficient and ineffective evaluative processes of the policy in practice.

Fensham (2009), Hamilton, Mahera, Mateng’e and Machumu, (2010) and OECD-GSF report (2006) contend that in realising the desired educational targets, it is important to closely scrutinize the policy statements and declarations to ensure a clear and shared focus where everybody understands the goals to be attained and the roles to play in achieving such visions.

10.2.5 Myths around Quality SE

The findings have shown that the importance of quality SE experiences in Tanzania cannot be understated. The respondents have shown a clear demand for quality SE in their JSS. However alongside this positive initiative there is a prevalence of several myths that happen to shape the understanding of quality SE. Myths in education remain to be issues of discussion in most education sectors in Africa, including Tanzania, because education is a highly emotional issue, which tends to cloud people’s thinking around their personal interests (Clark, 2004; Jay & Marcus, 2005). In education, often-repeated, unsupported claims shape thoughts and policies, and sometimes they lead to misunderstandings and misconceptions about the nature of problems in schools (Greene, 2005; Marcella, Kyalo, Kadenyi, & Kegode, 2009). As a function of myths, interests that shape individual expectations and the value attached to education suggest that the detrimental view of the education sector has a lot to do with stakeholders’ myths (i.e., the myths attached to what stakeholders believe about education).

While it is clear from the findings that schools are underfunded, that classes are too big to handle, that teachers are poorly motivated, and that there is a need for affirmative action to get more students into the colleges, most stakeholders took an ambivalent attitude towards quality SE and much of what they thought about quality SE was nothing more than a myth. Although their dissatisfaction with the way the SE system was practiced was clear, a closer analysis of their concerns showed a strong connection to negative myths that happened to shape their views towards quality SE. For example, parents still believed that proficiency in English as a language of instruction among learners reflected the quality of education offered. Myths were also evident when the stakeholders were describing the outcomes of quality SE and the fate of graduates, in that while some of them viewed SE as having no value to the students' futures, others believed that quality SE could only be provided outside the country. Combs (1979) and Jay and Marcus (2005) argue that the prevalence of myths among stakeholders can have a serious impact on any educational initiative. As such it is argued in this chapter that there is a need to challenge the existing myths, not with quick fix strategies, or with right/wrong answers, but rather with time taken to identify the myths and acknowledge that they exist, and then to commit to their revision.

10.3 Summary

The preceding discussion has shown that in the stakeholders' views, a large number of factors impede the provision of quality SE. At the strategic level, there is the lack of government support in terms of funding and resources, and present SE policies are ineffective. Further, the language of instruction and learning is problematic, and the mandated curriculum is irrelevant and unresponsive to the students learning needs and future aspirations. At a local level, community support for schooling is less than adequate, and educational myths are unhelpful. At a school level, there are both teacher and teaching issues and student and learning issues. Too few science teachers are available for the task required, and those who are teaching are underpaid, often poorly trained, and using ineffective pedagogical approaches. School management and leadership, assessment procedures, and examination focused teaching create their own challenges. Students are struggling with

language proficiency, a lack of direction, and are not interested in what current SE offers.

As noted in this chapter the challenges of providing quality SE in Tanzanian JSS are mainly context-specific. This situation suggests that the solutions that are likely to help in improving the quality of SE have to come from within the local context. While the need for developing quality SE in schools demands urgent action, Hamilton et al (2010) suggest that efforts to achieve that goal require a rigorously holistic re-orientation; re-polishing, re-engineering and rebranding of the SE sector. Today's SE challenges require a reflective way of assessing their impact on a student's ability to develop necessary science knowledge and skills for a future career in the field. In Tanzania as in many other countries, SE in its current form does not appear to be preparing students either for careers in science or as citizens who can confidently engage with science related issues. Even if students were doing extremely well by current measures, the question would remain as to whether doing more of the same would meet the needs of a changing world for which Tanzania must prepare its students to embrace SE as their future career path.

Barriers to quality SE are many. Partnerships among stakeholders need to be strengthened. Resources need to be gathered, and scientists, practitioners, policymakers, decision-makers and stakeholders need to work collaboratively to find solutions to the challenges presented in this chapter. Looking together, in the same direction, and pulling together too appears to be the way forward for SE in JSS. The next chapter presents the promising practices for providing quality SE in Tanzanian JSS.

CHAPTER ELEVEN

TOWARDS PROMISING PRACTICES FOR QUALITY SCIENCE EDUCATION IN TANZANIAN JSS

11.0 Introduction

This chapter focuses on identifying the promising practices shaping quality SE in Tanzanian JSS. Drawing from the data collected in this study, this chapter addresses the question: What could be done to overcome the limiting factors towards providing quality SE? The answers to this question are derived from the empirical studies and the respondents' views, all of which suggest a way forward. In this chapter, the strategies for providing quality SE are termed as "promising practices".

In the quest for change towards quality SE, the findings suggest a number of promising practices for policy and practice. They are discussed in the subsections that follow.

11.1 Promising Practices at Policy Level

At a policy level, the findings of this study have revealed weak frameworks, visions, and priorities for setting out the national agenda and enabling the achievement of providing quality SE in Tanzanian JSS. As such, the respondents suggested the following promising changes: policy changes; curriculum revision; modification of assessment procedures; change of the language of instruction; transformation of educational leadership and management; strengthening partnerships among SE stakeholders, and revision of science content.

11. 1.1 Policy Changes in Tanzania

The literature identifies that for quality SE to be provided in schools there is a need for an authoritative push from the national education policy that will drive the implementation process (Clare & Matt, 2014; Fensham, 2008; 2009). Hamilton et al. (2010) insist that strong political will and government commitment are required for realising this goal. It was clear among science alumni and most Heads of schools that there were limited commitments by the Tanzanian government to improve the existing policy for better SE outcomes. The respondents attributed the government's poor commitment in developing

quality SE to the gaps in the present education policy in terms of a lack of visionary goals, policy implementation, coordination, management, evaluation and review processes. The respondents' views find agreement with Sumra and Rajani (2006) who ask for a document that sets out policies and procedures on how to successfully attain the dream of providing high quality education and a robust guide for the implementation process. Similarly, Andres and Mattias (2006), Fensham (2008), and Hamilton, Mahera, Mateng'e and Machumu (2010) see the need for the adaption of clear, specific and well directed policy guidelines to realise the full potential of available human and material resources available for providing quality SE in Tanzania.

Recent science education literature supports the need for effective educational policies as a necessary component for guiding the development of vital skills among learners in an era of progress in science and technology, while boosting the quality and breadth of learning (Moja, 2000; Osaki & Tilya, 2004c; Weaver, 2011). Similar to this aspiration, respondents of this study suggest for a major transformation of the education policy and its philosophy. Promising changes for educational policy include:

1. Setting visionary goals and developing a clear, realistic, and well-defined national SE policy framework. This includes having effective and relevant policy goals that focus on developing competent individuals with science and technological skills, knowledge, and dispositions to contribute nationally and compete globally;
2. Re-orienting priorities in the policy by bridging the gap between teaching and learning, so that all learners complete their JSS science education with the knowledge and skills set out as goals;
3. Monitoring the implementation of policy in keeping with the focus of preparing students for post-primary science education and careers in science;
4. Developing the national quality SE standards and education monitoring schemes by ensuring that the learning achievements work in tandem with national and international standards of education and that educational resources are targeted for better educational achievements;
5. Establishing special national, regional, and district quality assurance and certification mechanisms to evaluate provision of quality SE in schools;

6. Readdressing the policy guidelines from being based on investments of efforts to being based on; meeting the growing demand for post-compulsory education, address contextual and global demands, and reinforce the provision of appropriate skills for both global and national competition.

Briefly, the respondents are asking for change in policy and practice to support the Tanzania Development Vision of 2025. Fensham (2009) and Clare and Matt (2014) relate such an aspiration to the process of strengthening the link between policy and practice.

11.1.2 Curricular Revision

The nature of the curriculum in practice was cited by most respondents (especially staff from school inspectorate departments, curriculum development departments and teachers) as essential to the successful provision of quality SE in schools. Bybee (2010b), Dillon and Redfors (2014), and Gray (1997) support the idea that the enactment of an appealing, relevant, and useful curriculum with quality instructional delivery is vital to learning, as it is likely to enhance achievements in SE. Tanzania is among many countries that are longing to provide quality SE in their JSS.

On the whole, most respondents of this study identified a lack of authentic and appealing science curricular experiences for JSS. They suggest the following promising changes of the science curriculum:

1. A shift towards a student-centred and a challenging curriculum which employs multidisciplinary and thematic approaches to eliminate student achievement gaps and lead to better achievements;
2. Developing the curriculum that prioritises science for all and science for those who will be encouraged to seek higher education and employment in science fields;
3. Shifting the curricular emphasis towards more focus on the use of relevant local and real-life examples that easily link the science subjects as academic disciplines with societal and student-daily experiences;
4. Shifting from a prescriptive content-based curriculum to a descriptive curriculum which is task-oriented, and defined by vital skills and competence descriptors;

5. A shift from wide curricular structure to highly focused and streamlined curriculum capable of meeting the market demands and the diverse learners' needs;
6. Shift the curriculum focus towards more relevant issues that address the needs and aspirations of the learners and their real life physical environment so that learners develop the scientific literacy;
7. Integrating co-curricular and extracurricular activities to enhance students learning experiences.

The respondents believed that the curriculum change was necessary to provide; students with positive learning experiences in science, foster them to develop interests in it, and help them to make informed choices about issues that affect their lives. This view is also strongly supported by Middlecamp (2008), Stewart (2010), Ryan (2008), and the World Bank (2011), all of whom insist on shaping science curricular around students' needs, societal expectations, and vital competencies that will enable them to them to live in a complex world that is socially, politically and economically challenging.

11.1.3 Modifications of Assessment Procedures

Assessment procedures, designs and monitoring frameworks are essential components for quality teaching and learning of science (Davis & Martin, 2008; Goodrum et al., 2001). While referring to the concerted efforts made by the Tanzanian government through the NECTA in improving the assessment procedures in Tanzanian JSS (see MOEC, 1999; URT, 1995; URT, 2001a), such initiatives, are described by most respondents (especially science alumni, teachers and Heads of schools) as being hampered by a number of challenges rooted in the way assessment procedures are planned, implemented and monitored.

Cobern, Schuster, Adams, Skjold, Muğaloğlu, Bentz, and Sparks (2014) and Hardman (2014) insist on the need to develop effective assessment procedures for a strong SE system. This view is contrasted by the respondents of this study who felt that schools were responding to this ambition by only working towards preparing learners to pass exams, proceed to the next level, and graduate into workplaces. While this practice in itself is admirable, it does not guarantee the development of learners' vital skills that would enable students to competently

face their futures, which calls for the need to change the way schools operate in providing SE. This also entails changing the way SE is evaluated and monitored (Fensham & Rennie, 2013). In achieving this goal, the respondents suggested the following promising changes in SE assessment procedures:

1. Developing a close relationship between the curriculum developing unit and the SE assessment department to provide synergy between curriculum implementation and intended student learning;
2. Shifting from norm-referenced examination practices headed by the National Examining Boards only (e.g., NECTA in Tanzania) to a criterion-referenced assessment system and continuous assessment practices which are co-monitored by both schools and the National Examining Board;
3. Complementing the use of pen-paper exams with student self-assessment practices and wide range of authentic assessment practices including; portfolio, reflective guides, performance charts, rubric framework, observation and interview of students' progress;
4. Shifting the assessment focus towards a concerted emphasis on assessment for learning and application of knowledge rather than assessment for mere recall of memorised facts;
5. Shifting from summative modes of assessment to formative types of assessment. This would likely to help in monitoring the students' progress in developing the expected knowledge, skills and values.

Apart from identifying the important role that quality assessment practice can play in improving educational outcomes, Vendlinski, Nagashima, and Herman (2007) and Corrigan, Gunstone, Jones (2013) advance the idea that while it is important to monitor the progress of student learning and teachers' classroom performance, it is also important to go beyond merely measuring students and teachers performances. These authors suggest for the following qualities, which align with the promising assessment practices suggested by the respondents. These suggest assessment should be:

1. Aligned with major disciplinary ideas, as well as with state standards and instructional materials;

2. Appropriate in levels of cognitive demand to reveal student understanding;
3. Consistent with current scientific knowledge;
4. Adequate in reliability;
5. Fair in expectations of students' opportunities to learn and free from cultural bias or insensitivities;
6. Feasible for classroom administration within typical time constraints;
7. Useful to teachers

11.1. 4 Change of the Language of Instruction

The language of instruction is a critical factor in determining student confidence in communicating ideas during learning (Brock-Utne, 2005). The use of English as the language of instruction in Tanzanian JSS continues to be controversial. While those who favour English language as the only medium of communication argue that it prepares students to work in the global economy, those who oppose it believe that English language alienates Tanzanian students from their own culture and distracts them from concentrating on the subject matter they are learning (Mrutu, Ponera, & Nkumbi, 2005; MoEVT, 2009a). The sentiments presented by most respondents with the exception of parents reveal that there are negative impacts with using English in science instruction. This view is supported by McKinley (2007), and Osaki (2005) who consistently argue that the continued use of English as a language of instruction not only affects learning but also presents a fundamental cultural clash between English and the native language, in this case Swahili.

While agreeing with the fact that Swahili as a language cannot be compared to English in terms of life span and popularity, it is important to consider using a language of instruction that allows the majority of Tanzanian students and teachers to easily understand the information being conveyed during the learning process. A valuable example can be drawn from countries such as Sweden and Thailand, which have managed to incorporate their languages into their respective curricular from early primary education onwards. Swedish and Thai are currently used as the media of instruction for all subjects from nursery school through to university. Though to some extent they have direct translation of the western science textbooks and that they fail to capture cultural context, efforts could be made by Tanzania to address this problem in its vision to

making Swahili the language of instruction in all science studies. There appears to be no obvious reason why Tanzanian students should continue using English (or French, German, or Arabic) books in secondary education. Most importantly it is necessary to address the issue of language of instruction against the majority's ability to communicate using the language.

11.1.5 Transformation of Educational Leadership and Management

The existence of effective leadership and management in education is an important component for the provision of quality SE in JSS (Bybee, 2010a; Marion & Gonzales, 2013). In the context of this study, educational leadership and management were seen by the respondents as requiring collaboration between stakeholders. The respondents wanted collaborative partnerships with inclusive decision-making and power and authority sharing to achieve the goal of providing quality SE in schools. This view rose from the present situation presented earlier, in Chapter 9 (*section 9.1.12*), where the stakeholders viewed communication and decision-making as being authoritative and limited, a situation which not only limited the stakeholders from making a contribution, but also affected the system's efficiency in achieving goal to provide quality SE both at school and national levels. As such, respondents suggested:

1. Shifting towards distributed, proactive and responsive leadership in which leaders show concern in staff involvement, act as agents of change and work towards bringing all key educational stakeholders together to work collaboratively toward common educational goals;
2. Shifting from the hierarchical and bureaucratic management styles of the industrial age to flatter, more distributed management systems of the information age, in which all stakeholders are expected to play a role in improving the quality of SE;
3. Shift from non-participatory leadership in which not everyone contributes towards a better outcome of education to an inside-out educational leadership approach that involves all individuals being involved in bringing change and maximising educational outputs;
4. Emphasis on committed and well supported administration that is able to inspire others to be useful to their society build relationships and develop team work to improve the quality of SE in schools.

Generally, the importance of good leadership and management practices in education is an issue that requires an urgent solution if the dream of providing quality SE is to be realised (Bybee & Fuchs, 2006; Darling-Hammond, 2007; Smith & Piele, 1989). While it is important for educational leaders and managers to be useful in responding to both learners' needs and societal expectation, the idea of which style of leadership should be used is still being debated and needs to move beyond the adoption of dogmatic styles of leadership which neither suit the context nor help to address the pressing issues in SE.

11.1.6 Strengthening Partnerships among SE Stakeholders

Effective partnership schemes and the involvement of all education stakeholders in education serves as the heart of any successful education system, and also creates the possibility of building a high-quality and successful education agenda (Education Review Office, 2005). Bishop and Berryman (2006) support the idea that quality SE can be provided when all key educational stakeholders are given chance to work together to make school experiences as good as they can possibly be, not just for academic improvement, but also in terms of support and establishing trusting relationships. Similarly respondents in this study identified the need for effective partnerships among key educational stakeholders, the partnership pattern which could lead to developing strong teamwork among them. The stakeholders' considered an inclusive and distributed responsibility model as desirable in creating a positive impact in SE.

Given the perceived necessity to have effective working partnerships among SE stakeholders in providing quality SE, the respondents believed that there was a disconnection among key educational stakeholders. These included disconnectedness between; the MoEVT departments (the TIE, NECTA, TEA, and the school inspectorate department), teachers and students, the schools and the community, school and business persons (as schools sponsors), parents and teachers, and the MoEVT and partner ministries in the effort to develop quality SE. The respondents also identified that there were weak relationships between other key education players, such as non-governmental organisations, national educational institutions, universities, and religious groups. Poor partnerships among educational stakeholders and poor

management linkages and synergies within the education sector are also described by Fensham (2008) as negatively influencing efforts to develop quality SE in schools. As such, several measures need to be taken in order to strengthen stakeholders' relationships:

1. Establishing inter-departmental relationships among the four vital departments at the Ministry of Education and Vocational Training. These departments include TIE (curriculum development), TEA (education funding), the Inspectorate Department (education monitoring) and the NECTA (evaluation of student performance);
2. Stimulating the participation of all key SE stakeholders to influence the SE delivery in schools and where a development in one sub-sector of education informs the developments above and below it;
3. Strengthening relationships and communication among SE stakeholders where everyone feels valued and important in achieving the goal of providing quality SE;
4. Developing links between formal and non-formal education sectors involved in influencing the process and the outcomes of SE in JSS, an initiative;
5. Catering for the increasingly complex demands of a diverse educational clientele (parents, students, workers, employers) and including all stakeholders in developing educational policy, resource allocation and service delivery.

Roth and Lee (2004) argue for the need to nurture both the internal and external interests that support quality SE in schools. They also argue that encouraging a broad community involvement in school development is likely to maximise the speed at which excellent standards in SE can be achieved. It is, however, argued that the partnerships and alliances in question should be based on common interests and the mutual respect of a diversity of views among stakeholders. This is necessary because the failure to consider those aspects may cause such partnerships to impose strong limiting forces on realising quality SE in schools.

11.1.7 Revision of Science Content

Historically the debate about relevant content or subject matter in SE has been around since the beginning of traditional schooling in the nineteenth century (Layton 1979; Rose, 2006). Most respondents believed that the quality of science content was an important component in reinforcing science learning and developing students' interest in it. Similarly, Rose (2006) contends that the lack of relevance of science content is regarded to be one of the greatest barriers for good learning and the development of interest in science subject among learners.

In respondents' views, Tanzanian SE content was prescriptive, abstract, context irresponsive and irrelevant to the Tanzanian context. This situation was identified by respondents of this study as not only negatively influencing the learning process but also hampering learners in having smooth interaction with the content. The respondents' views therefore echoed a number of promising reforms:

1. Embedding SE content within the interests and the lives of Tanzanian students and making sure that the SE content captured more Tanzanian contextual knowledge;
2. Increasing emphasis on the context-based science contents, which is likely to lead to an increased interest, involvement, engagement, persistence in science, appreciation of its relevance to their lives, and the understanding of science content among students;
3. Engaging students in science at an earlier age of learning (for example during primary education) so that when they enter the JSS education level they are ready to learn, persevere, and develop potential careers in science;
4. Integrating SE with technological studies, mathematics, engineering studies, agriculture, nutrition and/or physical education with the intention of demonstrating the connectedness between the knowledge in these disciplines;
5. Emphasis of going beyond immediately prescribed SE content to a wider view of the scientific world and its possibilities, the view which is likely to help in widening the boundaries of learning science.

Anamuah-Mensah (1998) and Ryder (2001) argue that the relevance of science content can possibly be realised when the community culture and its knowledge is allowed to contribute to the existing science content. In Tanzania, the most promising practice would likely involve incorporating learners' daily life experiences and indigenous knowledge and contextual socio-cultural issues into the existing science curriculum. Such an intervention would also mean creating a pathway for the local or indigenous knowledge and practices to influence the existing modern SE practices which are basically western in nature.

11.2 Promising Changes at a Practice Level

At practice level, respondents believed that there was a need for change in pedagogical practices and an acknowledgement that professional development was required for this to happen. There was also a call for appropriate strategies for facing the complexity of describing quality SE. The details for these strategies are discussed in the subsections that follow.

11.2.1 Pedagogical Shifts in Tanzanian SE

Adequate pedagogical practices in SE are identified as the bedrock for developing a good understanding of science and its application (Hestenes, 2013; King & Ritchie, 2012). Bull, Gilbert, Barwick, Hipkins and Baker (2010), and King and Ritchie (2012) have also argued for the necessity to have authentic pedagogical approaches that are aligned with the goals of improving the vital relationships between teachers, subject matter and the students. Similarly respondents felt that the inadequacy of pedagogical approaches among teachers was a limiting factor for providing quality SE. They described quality pedagogy disconnecting the smooth flow of information in the learning process.

In the respondents' view, the current teacher centred, traditional pedagogical practices in JSS science education are inadequate for providing quality science education. It is highly unlikely that current pedagogical approaches will support the development of individuals with an understanding of science content, procedures and how science works or to help students to become scientifically literate citizens which is the international focus of science education (Hodson, 2014).

Respondents, especially science alumni and school inspectors, acknowledged that most teachers employed some pedagogical practices which instead of helping students to learn how to think scientifically, led to them being told about science and asked to remember facts. This pedagogical focus calls for a shift towards approaches that fully engage learners as active members of the learning process. In particular, the proposed pedagogical promising changes include:

1. Shifting the pedagogical emphasis from one-size-fits-all models (such as teacher centred and content driven models of learning) to customised, personalised, and learner-centred pedagogies. Such pedagogies would make science meaningful and relevant to students' lives because they are based on collaborative or participatory learning, multiple sources of learning including books, internet sources, media reports, discussion, hands-on investigations, and student ownership of their own learning;
2. Shifting the pedagogical focus on content memorisation of scientific facts (that is, rote learning) to developing learners' understanding and application of science;
3. Shifting from more room for talk and less room for practical to less room for talk and more room for hands-on-activities (practical). This process is likely to allow learners to experiment, discuss, and reflect on what they have learned;
4. Promoting scientific thinking, developing skills for discussing dilemmas and problem solving;
5. Shifting emphasis of the current SE pedagogies to go beyond providing a science foundation for more advanced study and developing factual articulation in science to producing critical thinkers and scientists.

These suggestions revolve around the need to achieve sound, well-balanced, focused approaches of teaching and learning, and relevant pedagogies all of which are necessary for developing a high standard quality SE system. Hamilton, Mahera, Mateng'e and Machumu (2010), and Gluckman (2011) argue for an urgent need for a shift towards authentic pedagogy because such changes are likely to help in meeting the students' current learning needs as well as enabling them to own their learning outcomes. This initiative is also likely to enable the learner to change their roles in learning, from being the

subjects who attend school to collect facts and information from teachers, to attending school to develop knowledge, skills and improve their attitudes (Hipkins, Bolstad, Jones, Barker, Bell, Coll, Cooper, Forret, Harlow, Taylor, France, & Haigh, 2002).

11.2.2 Changes of Teacher Professional Development Plans

The quality of SE is enhanced by the quality of teacher professional development programmes (Anderson, 2002; Osaki, Ottevanger, Uiso, & van den Akker, 2002). Quality teachers' development programmes are described by Harris and Jensz (2006) as essential for producing quality teachers who are identified as vital enablers for providing quality student learning, interest and engagement in science. Hashweh (2013); Loughran, Mulhall, and Berry (2004); and Kitta (2004) identify the need to renew teachers' competencies to help them remain current with the latest SE advancements and educational demands in a rapidly changing world.

Similarly, respondents in this study identified that the availability of quality and up-to-date science educators was important in the efforts to improve quality SE in JSS. The respondents described the unavailability of quality science teachers being a result of gaps in areas of teacher recruitment, training, development, retention and monitoring. In respondents' views, these gaps increased the need to develop quality science teachers who have the necessary teacher competencies, skills, and awareness of the new developments in science.

Quality teachers were described by respondents as having four major attributes: academic knowledge and skills, relevant qualifications, teaching experience, and active participation in teacher development practices. To have all these attributes in a single teacher, active teacher support programmes (involving in-service workshops, pre-service mentorship programmes, teaching materials, and in-school support programmes), encouragement for higher education in science, and effective mentoring programmes for all science teachers are essential.

Generally, the respondents' views regarding the need to refocus the teacher development programmes were consistently centred on undertaking the following measures:

1. Strengthening on-going science teacher development programmes by creating opportunities for science teachers to meet regularly to share their professional challenges and improve their professional competencies, skills and knowledge on various developments in science, and boosting teachers' efficiency and confidence by providing them with other perspectives of teaching;
2. Changing the nature of the teaching profession from 'all comers' occupation' (an occupation for everyone) to a respectable profession by establishing Teacher Licensing Boards, thus also discouraging employment of untrained individuals as science teachers;
3. Re-focusing teacher education to meet current SE needs, and providing opportunity for those teachers who were trained through the fast track three months training program between 2000-2010 in the bid to address the teacher shortage, to receive a total two-year package of training within three years;
4. Complementing the short time scheduled block teaching practices in pre-service training with a year school based training, supported by a well-coordinated system of supervision, mentoring and face to face support;
5. Revival of the Teacher Resource Centres (TRCs) in all districts, and provision of human, financial, physical and material resources for ongoing professional development and support of teachers;
6. Development of an appropriate teacher performance appraisal system and implementing social service schemes to improve the economic wellbeing of teachers, including the working and living conditions of teachers, especially in rural and hardship areas;
7. Organising refresher courses in the form of seminars and science camps for science teachers by inviting more knowledgeable and experienced lecturers or specialists to talk to science teachers about new and promising practices in science education;
8. Devising new ways for attracting young, talented, qualified, competent, knowledgeable and dedicated science teachers.

Generally, respondents believed that revisiting teacher professional development frameworks were important for keeping teachers up-to-date and knowledgeable about new instructional strategies, latest SE standards, new

content developments and new ways of maximising student achievement. This view is in line with Burke, Schuck, Aubusson, Buchanan, Louviere, and Prescott, (2013); Harris and Jensz (2006); and Osaki (2002), who argue for the need to improve the quality of teachers and their teaching orientations.

11.2.3 Facing the Complexity of Defining Quality SE

Quality SE is identified in the literature as a complex and multi-faceted concept Goodrum, Hackling, & Rennie, 2001; Hakielimu, 2007; 2008; Knipprath, 2010; Ogunmade, 2005; Osaki, 2000a). Internationally the recent discussion has been focussed around what is meant by quality SE and envisioning how to achieve it on national and local levels. The findings of this study have revealed that while it is relatively easy to spot the indicators of quality SE, it is difficult to have a universal definition for it. This view is supported by Sifuna (2007) who argues that it has been difficult to settle on a definition of quality education that would apply to all situations. Green (1994), Tikly and Barret (2007), and Tikly (2010) have also consistently argued that it is not possible to adequately define the concept of quality education with a single definition, thus there is a need for multiple definitions for quality education that would accommodate the differing perspectives that exist for different stakeholders. Addressing the dilemma regarding the meaning of quality SE, the Namibian Minister of Higher Education, Training and Employment Creation argued that quality and standards of education should be measured in relation to the context and environment of a particular place (O'Sullivan, 2006).

Such conflicting views about quality SE refute approaches to understanding quality SE using a universal meaning. As such, the findings summarise five major factors to be considered in defining the concept of quality SE. These factors include the political and social context, the technology in use, the culture of the people involved, the educational stakeholders' composition, and the philosophy of education governing the processes and outcomes of education.

It can therefore be argued that although the concept of quality SE cannot be viewed as an absolute, simple, unambiguous, or unitary concept it does not absolve us from the responsibility of debating it, pursuing it, maintaining it and even planning to enhance it in schools. The challenge ahead is to make sure

that concerted efforts are in place to illustrate the complexities and ambiguities of the concept without affecting the learning process and outcomes.

Mushashu (2000), Nickel and Lowe (2010), Pigozzi (2006), SACMEQ (2005), and TEN/MET and Oxfam (2006) believe that there is a need to shift the focus of quality SE towards multiple emphases that would touch many interests in SE. In the context of this study, the respondents' diverse views identify six major emphases that can be adapted to make the SE experiences relevant to multiple interests. These emphases are quality SE for individual survival, individual protection against discrimination and insecurity, individual development (cognitively, psychologically and affectively), active participation and empowerment in decision-making, individual and social promotion (economically, socially, and culturally), and satisfaction from meeting individual and social goals, interests and desires. These aspects are summarised in the **S²DP³** model described in Chapter 9, which could also be used as model for measuring the quality of SE in schools.

11.3 Summary

This chapter presented the important paradigm shifts that the Tanzanian SE sector needs to undergo in light of the present challenges in JSS. In respondents' views, the achievement of the goal to provide quality SE in JSS requires major policy changes in relation to national goals; reform of curriculum and assessment practices, re-pronouncement of the language of instruction; changes to teacher preparation designed to provide support through ongoing professional development; transformation of educational leadership and management; strengthening partnerships among SE stakeholders, changes to pedagogical practices, revision of science content; and generally changing the ways of addressing the concept of quality SE.

The respondents illuminated certain promising practices that in their view could lead to quality SE in Tanzanian JSS. The challenge that remains is achieving a shared understanding, and thus vision, of what quality SE should look like. If the suggested promising practices are to be put in place, then the stakeholders will need to collectively negotiate and work together towards the common goals they will arrive at when they have the opportunity to contribute. With a will to do so, quality SE is achievable.

In the context of this study, undertaking these promising practices with positivist logic alone would limit the contribution of other, vital perspectives of providing quality SE. It is therefore important to consider pragmatic perspective in the process of making those promising practices achievable. This is because pragmatism is likely to provide a basis for obtaining multiple sourced interventions, which would ultimately help in making these prospective changes, and in turn in improving the quality of SE in Tanzanian schools. The next chapter presents the summary, conclusion and recommendations of the study.

CHAPTER TWELVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS OF THE STUDY

12.0 Introduction

This chapter revisits the overarching research objectives and the methodology used to answer the research questions, and offers a summary of the major findings of the study. The chapter also presents the implications of the findings, its contribution to knowledge and theory, and its conclusion. The chapter concludes by presenting the limitations of the study and offers specific recommendations for policy, practice, and for future research.

12.1 Literature Gaps

The review of literature was discussed in two chapters (chapter 4 and 5). This review of literature revealed the following gaps: a limited conceptualisation of quality education as an educational concept; huge changes to SE regarding its nature, goals, audience, and function, a situation which demands new approaches to understanding quality SE; the failure of a number of different approaches for providing quality SE, and a limited knowledge of new developments in SE due to only a few studies being conducted about quality SE in Tanzanian JSS. The literature has identified a growing desire for contextual and responsive approaches for providing quality SE in schools.

12.2 Aim of the Study

This study attempted to address the gaps identified in the literature by exploring ways to improve the quality of SE in Tanzanian Junior secondary school (JSS) from the perspectives of key SE stakeholders including educators, policy makers, parents, students, science alumni and selected education officers. The study addressed four major research questions: How quality SE was understood and articulated by its stakeholders; what the stakeholders considered were desirable features for quality science education in today's junior secondary schools; what challenges had JSS been encountering in the provision of quality SE; and what were the promising approaches or strategies that could be used to address the challenges of SE.

12.3 Methodology

A mixed method approach was taken in this study, largely drawing on qualitative data supplemented with quantitative data. The study employed a concurrent embedded research design of mixed methods grounded in pragmatic perspectives to gain access to stakeholders' views about quality SE in Tanzanian JSS. The study involved a total of 67 respondents including students, teachers, Heads of schools, parents, science alumni, and staff from TIE, NECTA, DEOs, TEA, SID and COSTECH. The methodology was designed to address most of the research gaps identified above.

12.4 Major Findings of the Study

By using the research methods identified in section 2.3, this study answered the four major research questions identified in section 2.2. A brief summary of the findings for this study is presented in the subsections that follow:

12.4.1 Stakeholders Understanding about Quality SE

The findings from this study have revealed that although there was some agreement among respondents on the way they understood quality SE, largely there were disagreements regarding what quality SE was. These included: diverse views regarding the meaning of quality SE, contestable approaches for understanding quality SE, debatable measures for quality SE, varied views regarding the descriptors of quality SE and the differing goals for quality SE.

The difference in respondents' views indicated that their views were determined by their particular interest in SE and the stakeholders' groups in which they belonged. For example, quality SE was understood differently by the stakeholder groups in that:

1. Policy makers believed that quality SE should produce responsible citizens;
2. Parents felt that quality SE should enable the learner to acquire necessary skills for future employment;
3. Science Alumni were in agreement with parents and policy makers in that they wanted students to acquire skills and knowledge for future employment and also to become responsible citizens;
4. Science teachers believed quality SE in JSS needed to prepare students for higher education and for future careers in science;

5. The students wanted quality SE to help them pass exams, continue to higher levels, and be successful in the future;
6. Science alumni, policy makers, and teachers were in agreement that quality SE needed to be context responsive, relevant to the learners' lives, functional and applicable to the learners after graduation.

Quality SE in this particular case is considered a relative concept, in the sense that the meaning of quality SE is relative to the particular context, type of respondents involved, and their needs. Such diverse and divided views on understanding quality SE are likely to limit the success of providing quality SE in schools, an outcome necessary to preparing Tanzanian students to confidently face the social and economic demands of today's world. This situation calls for a comprehensive, inclusive, and flexible approach such as pragmatism, an approach which could help in understanding, harmonizing, and compromising respondents' diverse views about quality SE towards what works best based on respondents' common agreed way forward.

12.4.2 Desirable Features for Quality Science Education

Quality SE was described as an education based on a clear policy, a contextually relevant curriculum and assessment practices, well-funded schools to provide adequate physical and material resources, adequate pedagogical practices, students' commitment and readiness to learn, well trained and well paid teachers committed to the profession. The desired outcome of such SE would produce students who are well prepared for further education and future employment in science careers, and responsible citizens.

The findings revealed that it is not enough to describe quality SE in terms of the aforementioned descriptors; other issues require attention when attempting to describe the quality of SE in Tanzania. Such issues include the culture, learning context, stakeholder composition, and the technological status of the situation together mark the new focus towards quality SE in today's schools. Tikly and Barret (2007), Tikly (2010), and UNESCO (2007), argue that the cultural and contextual responsiveness of educational practices, stakeholder characteristics, educational relevance, and the functionality and applicability of educational experiences are important descriptors to consider when planning quality SE.

12.4.3 The Issues and Challenges Leveraging the Provision of Quality SE in JSS

The findings of this study revealed various challenges facing SE in Tanzanian Junior secondary schools. Such challenges can be categorised as internal and external factors. On one hand the *internal factors* included matters such as the unavailability of learning support services and facilities (such as science labs and libraries), curricular irrelevance, insufficient teaching and learning resources, a lack of committed, qualified and experienced science teachers, and inadequate and un engaging pedagogical approaches. The findings also identified; poor command of English for both teachers and students, irrelevance, abstractness and context irresponsiveness of the science content in most of the science text books, poor student commitment, readiness and interest in learning science, inadequate assessment practices, inadequate teacher preparation, development and retention practices, and lack of school management and leadership.

On the other hand the *External factors* included issues such as inadequate government and community support, poor strategy towards quality SE, ineffective educational policy, unconstructive myths held by the stakeholders towards quality SE and the increase of education malpractice in education sector.

These challenges appeared to emanate from contextually and circumstantially multiple sources, thus they call for multiple perspectives in providing solutions. Respondents were in agreement that finding ways to solve these challenges was required; failure to do so would likely limit the learners' ability to develop necessary science skills in SE and discourage them from embracing SE as their future career. Despite the lack of empirical support, the pragmatic perspective is likely to be a relevant perspective for selecting appropriate solutions for such diverse challenges due to its ability to accommodate multiple views, cumulative practices, and promising approaches towards quality SE.

12.4.4 Suggested promising approaches and strategies for quality SE in JSS

In the quest for urgent solutions to the present challenges to Tanzanian SE, respondents were pragmatic in suggesting several important paradigm shifts to

be undertaken including: Policy changes; pedagogical shifts; curricular revision; modification of assessment procedures; reasonable choice of the language of instruction; improvement of teacher preparation, development and retention; practical transformation of educational leadership and management; strengthening partnerships among SE stakeholders; revision of science content; and facing the complexity of defining quality SE. Such crucial changes were identified for bringing immediate effects in meeting the students', school and community's expectations in SE.

It is considered important that developing these promising changes with positivist logic alone would limit the achievement of such an aspiration through other lines of inquiry (such as pragmatism) which are likely to be useful in providing best ways on which SE could be provided in Tanzanian JSS. As argued earlier, pragmatism is a desirable perspective because of its ability to provide a basis for obtaining multiple sourced solutions, as well as a rigorously holistic framework for making transformations of Tanzanian SE that would meet learners' needs, and address both contextual and global SE challenges.

12.5 Implications of the Findings

While the findings of this study are to be understood within the context of the research limitations and delimitations, its outcomes have significant implications. The study provides vital information from all SE stakeholders about the status of SE in schools, prominent issues influencing it and promising practices for its improvement. Generally the findings imply that:

1. Providing quality SE is a joint task that involves a number of stakeholders who are likely to have different views on how to approach it;
2. An attempt to understand and describe quality SE with a single line of evidence and explanation is unrealistic. Therefore cumulative evidence from a variety of sources is commendable;
3. The availability of financial, human, material and physical resources can directly influence community involvement, student engagement, and teacher motivation in the provision of quality SE, which is likely to lead to the improvement of students' performance;

4. Without clear and relevant philosophy and policy to provide effective guidelines on how to provide excellent learning experiences in schools, the achievement of quality SE is unlikely;
5. Without relevant curriculum; effective assessment procedures; quality science teacher preparation, and development and retention, adequate pedagogy in SE is difficult to achieve.

These general inferences have practical and the theoretical implications for provision of quality Science Education in Tanzanian Junior Secondary Schools.

12.5.1 Practical Implications

In practice the findings signify several implications to improve quality SE in Tanzanian JSS including the need for:

1. Broader consultation in the rebranding process of SE by including; policy makers, curriculum developers, educators, parents, students, the business community and other local actors;
2. Wider consideration of stakeholder characteristics such as occupation, education exposure, cultural background, the contextual pressures and the technology available and in use;
3. Increased attention to the present contextual and global challenges that define what is worthy learning in science;
4. Consideration of the nature and sustainability of the reforms in SE;
5. Broader rethinking of the philosophy governing the SE sector. The changes could start from the current philosophy of education in use;
6. Increased consideration of relevance, context responsiveness, functionality and applicability of the SE experiences as indicators of quality SE;
7. Application of the hybridised African-Tanzanian pragmatic perspective as a new framework for building a consensus of diverse conceptions about quality SE.

These interpretations of the findings present an increasing importance to rebranding and reengineering the SE system for better science learning outcomes for Tanzanian JSS learners.

12.5.2 Theoretical Implications

The research findings of this study also have implications for theory building. Chapters 2 and 4 have shown that competing theoretical perspectives on quality SE provide contrasting designs and/or strategies for understanding and improving quality SE in Tanzanian JSS. While such developments in understanding quality SE are important, no single approach can claim to be satisfactory in describing quality SE because the conceptions about quality SE, as revealed by the findings of this study, are so diverse. This therefore requires an accumulation of approaches towards building a consensus about important components for describing quality SE. However achieving consensus may not be an easy task suited to quick fix strategies. Comprehensive and multi-directional frameworks are required to understand a phenomenon, and embrace multi-sourced information regarding quality SE.

In this thesis, pragmatism as a line of inquiry and a new perspective to the Tanzanian context gets an opportunity to be refashioned and developed to explain the issues of quality SE in Tanzanian JSS. This process indicates its theoretical growth in a way that makes it more useful and applicable to diverse contexts and situations similar to Tanzania.

12.6 Contribution of the Study to Knowledge and Theory

This study has the following contributions to the body of knowledge about quality SE:

1. It has provided evidence about the current status of SE in Tanzanian JSS and the need to develop functional, relevant, and context responsive SE;
2. It has shown how different SE stakeholders understand and describe quality SE, the information that can be useful to policy makers and other SE stakeholders in making informed decision about improving quality SE in JSS;
3. The study has highlighted the complex issues that influence the efforts towards quality SE in Tanzania, the information which may be useful in developing informed decisions on how to overcome the present challenges in SE;

4. It has demonstrated the importance of taking into consideration a new philosophical foundation of pragmatism which brings together all lines of inquiry to provide vital suggestions for improving the quality of SE in Tanzanian secondary schools;
5. It has contributed to the definition of a systematic and sustainable framework for quality SE in Tanzanian secondary schools which could guide the debate around reforms in SE through evidence;
6. It has a new platform with which pragmatism as both a research philosophy and an approach can be developed and advanced in African contexts, which is useful in understanding the issues of SE in Tanzania and other countries similar to it;
7. It has stimulated a paradigm shift from the closed, non-flexible frameworks presently applied in Tanzanian education to more open, flexible, and pluralistic approaches; opening debates about the application of pragmatism in solving the SE issues and challenges in countries similar to Tanzania.

It is anticipated that the contribution of this study to the body of knowledge, theory and future studies will help to accelerate the efforts to improve quality SE in Tanzanian JSS. It is also hoped that through this study SE in the near future will be collectively influenced, relevant to the learners, responsive to both contextual and global demands; and functional and applicable to the Tanzanian learners.

12.7 Conclusion

Quality SE has been identified in this thesis as one of the important basic prerequisites for individual learners to respond appropriately to a variety of social and cultural contexts. The provision of quality SE in schools has therefore been described as an important initiative to undertake at this era, if a country is to remain globally competitive. In Tanzania the initiative to provide quality SE in schools has brought a need to reform the SE system. In the context of this study, such reform may involve an intensive inquiry about the relevance, context responsiveness, functionality and applicability of the present SE practices to the Tanzanian learners. The answers to these queries are likely to have an impact on the following: the philosophy of education in Tanzania,

educational policies in practice, SE curriculum in use, teachers' pedagogical practices, and the assessment procedures.

As evidenced by this thesis, quality SE in Tanzanian JSS requires a multi-sourced intervention, the involvement of multiple key stakeholders, and multiple approaches to understanding its meaning, descriptors, and goals. Establishing the debate about quality SE on multi-sourced grounds not only helps to bring the discussion about quality SE closer to the local community level, but also increases the degree at which stakeholders are likely to own the educational outcomes. This situation is considered by Tikly and Barret (2007) and Tikly (2010) as important to developing a strong national education system.

With the existing diversity of views about quality SE in Tanzanian JSS, it is considered important to have a relevant approach that can help to harmonise existing differences towards a common purpose that meets learners' needs, future expectations, and contextual challenges which ultimately define what is worthy learning in science. In pragmatic point of view such harmonisation could be informed by accumulated practice, the utility function of the desired SE experiences, and multiple views on what works best than what is inherently true.

The need to undertake substantial changes to Tanzanian SE is becoming stronger because most of the SE practices in the Tanzanian education system have roots in colonialism, whose aim was to herald and perpetuate the western culture in education. These practices have in turn led to a disconnection between classroom SE experiences and the real life experiences of learners. To solve such disconnection requires a shift in approaches from the colonial-based educational approaches which celebrate fixed, faulty, narrow confines, absolutism and conservative modes of looking at education to pragmatically based approaches that accommodate the aspects of relevance, functionality and context responsiveness education.

In the context of this thesis, pragmatism as a new perspective in Tanzania is likely to serve as a foundation on which the promising practices in Tanzanian SE may be established, challenging Aristotelian methods (belief in a given reality) in education which have been celebrated and embraced as dogmas in Tanzanian SE since independence; closing the gap that exists between what is

learnt in schools and societal realities (creating the link between school learning experiences and students daily realities); and directing the ideological commitments of the nation and embodying these commitments in a truly life-long education system which is relevant and functional to the society. Finally, pragmatism would help in harnessing multiple paradigms of dialectic approaches in addressing the quality of SE as effectively as possible and creating a useful education system whose outcomes completely meet the demands and expectations of Tanzanian communities.

It should be understood that using a pragmatic approach which welcomes multiple views, a range of things to be implemented should be expected. The present study has highlighted a number of changes to be done towards provision of quality SE in Tanzanian JSS. The evidence in this study indicates that there are no short cuts for achieving the goal of providing quality SE in schools. Each suggested change should be taken seriously as it has a direct impact on others (see chapter 11).

12.8 Limitations of the Study

This study is grounded in a pragmatic perspective. As such, the data analysis and interpretation are based on pragmatic principles. Diverse perspectives were sought in discovering ways to provide quality SE in Tanzanian JSS.

It is relevant to note that there can be multiple realities to a single phenomenon (Creswell, 2003; Rorty, 2004). This study explored the perspectives of educators, policy makers, parents, science alumni and students on improving quality SE and used their views as a basis for understanding how such an aspiration could be achieved in Tanzanian JSS. Despite the use of mixed methods and a pragmatic perspective in collecting data, it is possible that if different respondents were involved, the findings could be different.

Further, despite the researcher's cautious efforts to control the research's limiting factors, time emerged as constraint in this study. At the time this study was conducted Tanzanian schools were finishing a term and looking forward to a long holiday. Further, students were preparing themselves for final national examinations. Due to time constraints not all external stakeholders such as employers and other educational partners (who are key consumers of SE

outputs) were involved in the study. It is likely that time limited the richness of the data.

The presented study is delimited to the SE in Tanzanian JSS. Due to this delimitation it is entirely possible that there are differences in quality values of SE practices from other subject disciplines. However, this does not limit its application to other disciplines and to other nations similar to Tanzania because the study raises general issues in SE that may apply to other regions and other disciplines in education.

It should also be understood that this study reported the Tanzanian stakeholders' perspectives about what was meant by quality SE, its limiting factors, and the best ways to overcome challenges. As such views are likely to be dependent on location and the belief of what quality SE means given contextual factors, standards and contextual challenges.

All interactions in this study were carried out in both Swahili and English languages. The researcher translated all interviews, questionnaires and documents into English. Since there was not always a direct, word-for-word translation between the two languages, the possibility exists that some meaning may have been lost in the process of translation. Furthermore, since the research is generally a context specific its findings may not be generalizable to other contexts.

12.9 Recommendations for Specific SE Stakeholders

The provision of quality SE in Tanzanian JSS requires a number of issues to be re-addressed and urgent changes to be made. In addition to the changes on SE highlighted in chapter 11; this subsection offers recommendations to specific groups of stakeholders. It is possible that several proposals have already been suggested but the aim of this study is not to refute those useful suggestions but see how they can be rebranded to improve the educational processes in present JSS. In view of prior implication of the findings, the recommendations in this section are discussed in the subsections that follow:

12.9.1 Tanzanian Government

There is no substitute for national political leadership and management accountability when it comes to the provision of quality SE in JSS. With the

current management practices in the education sector and the demands for change, the present study recommends that, the government need to:

1. Shift accountability of educational outcomes from being directed to the government to being directed to the public.
2. Develop better synergies between education policy makers and those who implement the policy action plans;
3. Improve both financial and materials support of SE for it to be able to cater to increasingly complex demands of a diverse educational clientele (parents, students, workers, employers);
4. Provide the opportunity for stakeholders to influence educational policy, resource allocation and service delivery;
5. Support and provide guidance for teacher professional training, development and retention programmes so that enthusiastic and committed teachers are not lost from the science stream, as they take up other lucrative jobs;
6. Encourage top category of secondary school graduates entering teaching and put in place motivational schemes for teachers so that best teachers can be produced;
7. Improve the science teachers' salary structures and incentives schemes to attract more science teachers to rural communities by giving them higher salaries and special benefits in order to motivate more people to consider a science teaching career;
8. Set aside funds to buy mobile laboratories to help in addressing the problem of the shortages of labs, instead of leaving the matter to the communities alone;
9. Change the District Teacher Resource centres, which are currently not functioning, into ward laboratories and student science resource centres/libraries, or even opting for joint laboratories whose costs could be shared by two or more schools;
10. Registration of teachers to control the non-teacher trained individuals to engage in teaching.
11. Encourage and motivate of science teachers (both pre-service and in-service) by creating opportunities for on-going teacher professional

development (such as conferences, seminar and workshops) to update their knowledge.

Generally, the government needs to consider significant changes to curriculum, teacher education and development, as well as assessment framework if the quality of science education in the JSS is to be improved. The evidence suggests that if present conditions continue, it is likely that fewer students will opt to study and seek careers in science.

12.9.2 Teachers

Teachers have a unique role to play in SE. They are charged with creating a supportive environment in which children can engage in learning science, and with devising appropriate ways by which educational visions can be translated into knowledge gains. In light of the present need to provide quality SE in Tanzanian JSS, teachers need to:

1. Reflect on their own teaching by critically examining their pedagogical techniques and finding ways to modify their own practices;
2. Use their professional and academic freedom proactively; share ideas and best practices that work in their classrooms; give students opportunities to think, and use examples that make science relevant to students and the outside reality;
3. Agree upon professional codes of ethics and a set of rules for those recruited in teaching;
4. Improve and update their knowledge on the subject matter and new pedagogies in SE so that they can be able to teach with confidence;
5. Develop an interest in their learners by taking into account what students are learning and whether what they learning help them to attain better achievements;
6. Developing a positive and conducive environment for learning by creating and sustaining learner friendly learning approaches;
7. Encouraging learners to participate actively, enthusiastically, critically, and passionately in learning science and doing the very best for their students to attain vital knowledge and skills;
8. Building a good relationship with parents and other friends of SE, within and outside the school;

9. Enhancing their belief in their power to improve learning among their students by being willing to try new possibilities available for them to make such goal achievable;
10. Developing proficiency in the language of instruction, in order to improve their ability to communicate effectively with their learners in the learning process;
11. Developing individual morale and dedication towards meeting the goals of teaching science;
12. Developing a sense of caring, compassion, and responsibility for helping learners to achieve their individuals learning dreams in science.

Generally, teachers need to ensure that among others things individual learners' needs are taken into account; learners are developed into autonomous lifelong individuals; learners acquire vital skills, knowledge, attitude, and values; and more importantly the teaching process is adopted to a multicultural setting with a use of new technologies in learning (Banks, 2008).

12.9.3 Community and Civil Society Organisations

This category includes the non-governmental organisations, business groups, faith-based organisations, and community organisations that play a valuable role in children's education both in and out of the classroom. In the quest to provide quality SE in Tanzanian JSS, the community and civil society organisations need to:

1. Take an interest in and responsibility for improving SE by claiming and demanding for their children's rights to quality SE;
2. Demand an opportunity to take part in decision making processes regarding their children's science learning;
3. Re-evaluate their commitments to provide material and financial support in schools' science related projects;
4. Establish science fairs to provide a platform for industries to show case their products, academia to interact and inform the public about their discoveries, and students to learn science outside of the classroom;
5. Demand an acknowledgement of their concerns about achieving quality and relevant SE in schools. Active community involvement in schools' educational matters is likely to not only speed the achievement of

excellent standards in education but also plays a great role in catalysing the learners' readiness to learn;

6. Share responsibilities with the school for their children's learning and success;
7. Monitor the progress of JSS and hold governments, schools and all other education stakeholders accountable for their responsibility to develop the standard of SE in schools toward quality.

Generally, the community needs to re-examine how their core contributions and support may be repositioned as an asset to improve the quality of SE in schools.

12.9.4 Curriculum Developers

Respondents believed that the Tanzanian curriculum development unit houses weak SE frameworks, which have not only failed to produce independent individuals but have also failed to meet individual learners' needs, and those of larger society. In view of such a problem, this study recommends that, the curriculum developers need to:

1. Make sure that the curriculum in practice focuses on innovative and challenging characteristics of science learning. This would require tuning the curriculum content into more relevant issues that address the needs and aspirations of the learners, and helps learners develop scientific literacy which is useful to their everyday lives;
2. Translate the policy guidelines into achievable science learning goals for all learners;
3. Develop an SE curriculum that is context responsive and useful for the students' future careers in science;
4. Develop the curriculum materials with specific guidelines on the use of relevant local and real-life examples;
5. Refocus the science curriculum materials towards developing learners into skilled, confident, knowledgeable, and useful individuals in their society;
6. Develop the curriculum that will provide a clear link between what is learned in the classrooms and the reality outside of school;

7. Carry an honest evaluation of whether the present SE curricular frameworks are meeting minimum national science education standards or not. The result of this analysis is likely to help to discover new emphases for quality SE;
8. Prioritise the provision of quality SE through redoubling investments in teacher training programmes on the appropriate use of the curricular materials;
9. Scale up research on SE promising curricular orientations that would work best in Tanzanian;
10. Devise a comprehensive science curricular reform to achieve high-quality SE for everyone who chooses to study it.

12.9.5 Students

Given a four years commitment to a JSS science education, Tanzanian JSS students need to:

1. Actively demand their right to quality SE through open dialogue with teachers, families, and communities;
2. Develop mutual and supportive relationships among themselves and teachers;
3. Maximise their efforts by accepting individual responsibility for their own learning, and shaping their learning achievements and future lives;
4. Fulfil the promises of education by increasing their engagement in science and developing themselves into productive and thoughtful citizens who can give back to their society;
5. Reflect and apply whatever they might have learned in school for the betterment of their lives;
6. Take consistent and effective action in pursuing and achieving all the learning goals and dreams they have in science;
7. Develop positive feelings, interests, values, beliefs, and behaviours that will help them persist and persevere in their journey to develop their science careers;
8. Discover self-motivating characteristics in science learning by critical reflection upon personally meaningful goals;
9. Believe in themselves as capable beings who can be key assets to the provision of quality SE in schools.

Generally, improving the provision of quality SE will only be possible when students are ready and willing to engage themselves in learning, and are optimistic about achieving the goal. Also it is important for students to possess positive attitude, interest, values, beliefs, feelings, and dispositions as necessary prerequisites for their persistence and perseverance in science.

12.10 Recommendations for Future Research

Further studies in the area of Tanzanian education, and SE in particular, are critical: They can help in obtaining a better understanding of the complexities and issues involved in improving quality SE in schools.

More inquiry is needed regarding political dynamics and their impacts on education. It was clearly evident in the findings of this study that the political arena had a limiting function towards delivery and assurance for quality SE in schools. Research can be done to identify reasons why it has not been possible to prevent politicians from negatively influencing the practices and the outcomes of education, SE in this particular case.

Another area warranting further studies is the role of education administrators and managers in initiating change towards quality SE practice in Tanzanian JSS. It would be informative to conduct a study about beliefs and values held by the wider Tanzanian community about quality SE. This would provide useful ideas about students' disengagement, loss of interest, and poor attitude towards science subjects.

The findings of this study have involved two regions, with an assumption that they were representative in delineating the stakeholders' perspectives towards quality SE. It would be of great benefit to conduct similar studies in all regions in Tanzania, and at other levels of education to identify the similarity and the differences of the findings, a process which is likely to help in generalisation.

Because the study was a cross-sectional investigation, it was difficult to visit a lot of SE stakeholders regarding their perspectives about quality SE in Tanzanian JSS. Therefore, a study ranging from primary education through to the tertiary educational level would be interesting to show in detail the trend of quality SE in Tanzania.

All the findings from this study are only suggestive and tentative in nature and a 'petite generalisation' as nicknamed by Stake (1995; 2005). As such, other researchers from similar contexts to Tanzania may use the results to create better frameworks and/or improve the ways in which SE can best be enacted in their specific places, but must bear the limitations in mind.

While the concept of quality has been broadly explored in this study still, there are questions that remain unanswered and probably could form a clue for further investigation. These questions include: Does the difference in conceptions about quality SE mean typologies of quality SE? How can quality SE be best explained in different contexts? How can we recognise that a child has received a high quality education? What type of quality education is worth talking in this era of information age? Do we really need to have universal standards of quality SE even when different people from different contexts experience different needs and challenges? These are all questions Tanzanian education will need to answer in the near future.

REFERENCES

- Adams, D. (2002). Education and national development: Priorities, policies, and planning. *Education in Developing Asia Series*, Vol. 1. Asian Development Bank and Comparative Education Research Centre, University of Hong Kong.
- Adas, M. (1989). *Machines as the measure of man: Science, technology, and ideologies of Western dominance*. Ithaca, NY: Cornell University Press.
- Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education*, 27, 1-52.
- Aikenhead, G. S. (2001). Students' ease in crossing cultural borders into school science. *Science Education*. 85, 180-188.
- Aikenhead, G.S. (2006). *Science education for everyday life: Evidence-based practice*. New York: Teachers College Press.
- Aikenhead, G.S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*, 2(3), 539-620.
- American Association for the Advancement of Science (AAAS). (1989). *Science for all Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology*, Vol. 1. Washington, DC Retrieved on 23rd July 2011 from <http://www.project2061.org/publications/textbook/hsbio/report/crit-used.htm>.
- Anamuah-Mensah, J. (1998). Native science beliefs among Ghanaian students. *Internal Journal of Science Education*, 20(1), 115-124.
- Anamuah-Mensah, J., Mereku, D. K., & Asabere-Ameyaw, A. (2004). *Ghanaian junior secondary school students' achievement in mathematics and science: Results from Ghana's participation in the 2003 trends in international mathematics and science study*, Accra: Ministry of Education Youth and Sports.
- Anderson, C. (1987). Political philosophy, practical reasons and policy analysis. In F. Fischer and J. Forester (Eds.), *Confronting values in policy analysis: The politics of criteria* (p. 22-44). Newbury Park, CA: Sage.
- Anderson, C. (1990). *Pragmatic liberalism*. Chicago, IL: University of Chicago Press.

- Anderson, S. E., (ed.) (2002). *Improving schools through teacher development: Case studies of the Aga Khan foundation projects in East Africa*. Lisse, the Netherlands: Swets and Zeitlinger.
- Andres, A., & Mattias, N. (2006). *Tanzania education sector policy: Overview Paper*. Dar es Salaam, Tanzania.
- Anzaldua, G. (1999). *Borderlands*. Aunt Lute Books. San Francisco.
- Arbeiter, S., & Hartley, S. (2002). Teachers' and pupils' experiences of integrated education in Uganda. *International Journal of Disability, Development and Education*, 49 (1), 61-70.
- Ardalan, K. (2008). The philosophical foundation of the Lecture-Versus-Case controversy. Its implications for course goals, objectives and contents, *International Journal of Social Economics*, 35 (1 &2), 15–34.
- Arif, M., Smiley, F. M., & Kulonda, D. J. (2005). Business and education as push-pull processes: An alliance of philosophy and practice. *Education*, 125 (4), 602.
- Asabere-Ameyaw, A., Dei, G.J.S., & Kalawole, R. (2012). Conclusion: Re-visioning science and indigenous education in Africa: Meeting future challenges. *Contemporary Issues in African Sciences and Science Education*, 217–222.
- Banks, J.A. (2008). *An introduction to multicultural education*, 4th ed. Pearson Education, Inc. Boston, MA.
- Barton, A. C., Ermer, M. L., Burkett, T. A., & Osborne, M. D. (2003). *Teaching science for social justice*. New York: Teachers College Press.
- Best, J. W., & Kahn, J. V. (2006). *Research in education* (10thed). Boston: Pearson.
- Biesta, G.J.J., & Burbules, N. (2003). *Pragmatism and educational research*. Lanham, MD: Rowman and Littlefield.
- Bishop, R., & Berryman, M. (2006). *Culture speaks: Cultural relationships and classroom learning*. Wellington: Huia.
- Bolstad, R. (2011). *Taking a "future focus" in education: what does it mean? An NZCER Working Paper from the Future-Focussed Issues in Education (FFI) Project*. Wellington: New Zealand Council for Educational Research.

- BouJaoude, S. (2006). *Bridging the gap between scientists and science educators in the Arab region: Report Presented at the Expert Group Meeting on "Bridging the Gap between Scientists and Science Educators*, organized and sponsored by the UNESCO office, Cairo, Egypt.
- Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks, CA: Sage.
- Boyce, C., & Neale, P. (2006). *Conducting in-depth interviews: A guide for designing and conducting in-depth interviews for evaluation input*. Watertown: Pathfinder International.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, 77-101.
- Brock-Utne, B. (2005). *Learning through a familiar language versus learning through a foreign language: A look into some secondary school classrooms in Tanzania: A Paper Presented at LOITASA Conference Held at UWC, Cape Town*.
- Bryman, A. (2008). *Social research methods*. Oxford: Oxford University.
- Bull, A., Gilbert, J., Barwick, H., Hipkins, R., & Baker, R. (2010). *Inspired science: A Paper Commissioned by the Royal Society and the Prime Minister's Chief Science Advisor*. New Zealand Council for Educational Research.
- Burke, P. F., Schuck, S., Aubusson, P., Buchanan, J., Louviere, J. J., & Prescott, A. (2013). Why do early career teachers choose to remain in the profession? The use of best–worst scaling to quantify key factors. *International Journal of Educational Research*, 62, 259-268.
- Bybee, R. W. (1993). *Reforming science education: Social perspectives and personal reflections*. New York: Teachers' College Press.
- Bybee, R.W. (2006). *Science teaching in the 21st century: Five themes for educational leaders*. Dubuque, IA: Kendall/Hunt Publishing Company.
- Bybee, R.W., & Fuchs, B. (2006). Preparing the 21st century workforce: A new reform in science and technology education. *Journal of Research in Science Teaching*, 43 (4) 349–52.

- Bybee, R. (2010a). A new challenge for science education leaders: Developing 21st century workforce skills. *In science education leadership: Best practices for a new century*, (ed). J. Rhoton, 33–49. Arlington, VA: NSTA Press.
- Bybee, R. (2010b). *The teaching of science: 21st-century perspectives*. Arlington, VA: NSTA Press.
- Cameron, J., & Dodd, W.A. (1970). *Society schools and progress in Tanzania*. Oxford: Pergamon Press.
- Campbell, C., & Rozsnyai, C. (2002). Quality assurance and the development of course programmes. *Papers on Higher Education Regional University Network on Governance and Management of Higher Education in South East Europe*. Bucharest, UNESCO.
- Chapman, P.M. (2007). Traditional ecological knowledge (TEK) and scientific weight of evidence determinations. *Marine Pollution Bulletin*, 54, 1839 - 1840.
- Chonjo, P., & Welford, G. (2001). Reasons for the poor performance of students in A-level science examination in Tanzania. *Papers in Education and Development*, 21, 39-51.
- Chonjo, P. N., Osaki, K. M., Possi, M., & Mrutu, S. (1996). *Improving science education in secondary schools: A situational analysis of selected government secondary schools in Tanzania mainland*. Dar es Salaam, Tanzania: Ministry of Education and Culture.
- Cho, J., & Trent, A. (2006). Validity in qualitative research revisited. *Qualitative Research*, 6 (3), 319-340.
- Chung, S., & Walsh, D.J. (2000). Unpacking child-centeredness: A history of meanings. *Curriculum Studies*. 32, 215-234.
- Clarke, R. M. (1983). *Family life and school achievement: Why poor Black children succeed or fail*. Chicago: University of Chicago Press.
- Clark, J. (2004). Educational myths as a framework for education policy: Towards a new myth. *New Zealand Annual Review of Education*, 13, 5-19.
- Cobern, W.W. (Ed.) (1998). *Socio-cultural perspective on science education*. Dordrecht. The Netherlands: Kluwer Academic Publishers.

- Cobern, W. W., & Loving, C. C. (2001). Defining" science" in a multicultural world: Implications for science education. *Science Education*, 85 (1), 50-67.
- Cobern, W. W., Schuster, D., Adams, B., Skjold, B. A., Muğaloğlu, E. Z., Bentz, A., & Sparks, K. (2014). Pedagogy of Science Teaching Tests: Formative assessments of science teaching orientations. *International Journal of Science Education*, 36(13), 2265-2288.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. London: Routledge.
- Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th ed.). New York, NY: Routledge.
- Combs, A.W. (1979). *Myths in education: Beliefs that hinder progress and their alternatives*. Boston: Allyn and Bacon.
- Corrigan, D., Gunstone, R., Jones, A (Eds.) (2013). *Valuing assessment in science education: Pedagogy, curriculum, and policy*. Dordrecht, New York: Springer. Doi: 10.1007/978-94-007-6668-6_11.
- Cornell, C. (2010). *The importance of secondary education*. Retrieved on Sunday 9 January 2011 from <http://ezinearticles.com/?The-Importance-of-Secondary-Education&id=5298983>.
- Cosijn, E., & Ingwersen, P. (2000). Dimensions of relevance. *Information Processing & Management*, 36 (4), 533-550.
- Creswell, J. W. (2003). *Research design: Qualitative, quantitative and mixed methods approaches*. Thousand Oaks, CA: Sage.
- Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research (2nd ed.)*. Upper Saddle River, NJ: Pearson Education, Inc.
- Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage.
- Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches (3rd ed.)*. Thousand Oaks, CA: Sage.
- Curtis, S. J., & Boulton, M. E. A. (1968). *A short history of educational ideas*. London, University Tutorial Press.
- Dahlberg, G., Moss, P., & Pence, A. (1999). *Beyond quality in early childhood education and care: Postmodern perspectives*. London: Falmer Press.

- Darling-Hammond, L. (2000). How teacher education matters. *Journal of Teacher Education*, 51 (3), 166-173.
- Darling-Hammond, L. (2000c). *Teacher quality and student achievement: A review of state policy evidence: Educational Policy Analysis Archives*. Retrieved from <http://epaa.asu.edu/epaa/v8n1> on 24th of august 2012.
- Darling-Hammond, L. (2007). Education leadership: A bridge to school reform. *A paper presented at the Wallace Foundation's National Conference*. New York City.
- Davis, J., & Martin, D. (2008). Racism, assessment, and instructional practices: Implications for mathematics teachers of African American students. *Journal of Urban Mathematics Education*, 1 (1), 10-34.
- Dawson, C. (2000). Upper primary boys' and girls' interests in science: have they changed since 1980? *International Journal of Science Education*, 22, 557-570.
- Dei, G. J. S. {Ed} (2011). *Indigenous philosophies and critical education*. New York: Peter Lang.
- Dei, G. J. S. (2012). Indigenous anti-colonial knowledge as 'heritage knowledge' for promoting Black/African education in diasporic contexts. *Decolonization: Indigeneity, Education & Society* 1, (1), 102-119.
- Delputte, S. (2013). The EU as an emerging coordinator in development cooperation: perspectives from sub-Saharan Africa1. *Afrika Focus*, 26(1), 99-107.
- Dennett, D. (1998). *Brainchildren: Essays on designing minds*. Cambridge, MA, MIT Press.
- Denzin, N. K., & Lincoln, Y. S. (2005). The discipline and practice of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (3)1-32). Thousand Oaks, CA: Sage.
- Dewey, J. (1897). My Pedagogic Creed. *School Journal*. 54, 77-80
- Dewey, J. (1903). *Logical conditions of a scientific treatment of morality*. Chicago, IL: University of Chicago Press.
- Dewey, J. (1938b). *Logic: The theory of inquiry*. New York: Carbondale, IL: Southern Illinois University Press.
- Dewey, J. (1944). *Democracy and education*. New York: The free press.
- Dewey, J. (1956). *The child and the curriculum, and the school and society*. Chicago, IL: University of Chicago Press.

- Dewey, J. (1973). Education as a social function. In S. D. Sieber & D. D. Wilder (Eds.). *The school in society* (p. 28–33). New York, NY: The Free Press.
- Dillon, J., & Redfors, A. (2014). Introduction of Strand 10: Science curriculum and educational policy. In Constantinou, C.P. Papadouris, N., & Hadjigeorgiou, A. (ed). *E-book proceedings of the ESERA 2013 conference: Science education research for evidence-based teaching and coherence in learning* (p1-6) Science Education Research Association.
- Downes, S. (2005). *Some principles of effective E-learning*, Canada, National Research Council, Retrieved on 20th Feb, 2011 from <http://www.downes.ca/cgl/website/page.cgi?db>.
- Duit, R., & Treagust, D. F. (2003). Conceptual change: a powerful framework for improving science teaching and learning. *International Journal of Science Education*, 25(6), 671-688.
- Enoh, A. O. (1995). *Introduction to philosophy of education*. Jos: Midland Press (Nigeria) Ltd.
- Education Review Office (ERO). (2005). *Student learning in the information landscape*. Wellington, New Zealand: Education Review Office.
- Fafunwa, A.B., & Aisiku, J.C. (ed.) (1982). *Education in Africa: A comparative survey*, London: George Allen & Unwin.
- Felder, R. M., & Brent, R. (2009). Active learning: An introduction. *ASQ Higher Education Brief*, 2 (4).
- Fensham. P. J., & Rennie, L. (2013). Towards an authentically assessed science curriculum. In Corrigan, Deborah, Gunstone, Richard, & Jones, Alister (Eds.) *Valuing assessment in science education: Pedagogy, curriculum, policy*. Springer science and business media B.V. (p. 69-100), London.
- Fensham, P. J. (2011). Globalization of science education: Comment and a commentary. *Journal of Research in Science Teaching*, 48 (6), 698-709.
- Fensham, P. J. (2009). The link between policy and practice in science education: The role of research. *Science Education*, 93(6), 1076–1095.
- Fensham, P.J. (2008). *Science education policy making: Eleven emerging issues*. Paris: UNESCO.

- Fensham, P.J. (2004). Increasing the Relevance of Science and Technology Education for all students in the 21st century. *Science Education International*, 15 (1), 7-27.
- Fleer, M. (2008). Understanding the dialectical relations between everyday concepts and scientific concepts within play-based programs. *Research in Science Education*, 39, 281–306.
- Fletcher, A. (2003). *Meaningful student involvement: Guide to inclusive school change*. Olympia, WA: The Freechild Project.
- Fontrodona, J. (2002). *Pragmatism and management inquiry*. New York: Quorum Books.
- Fraser, B. J. (1994). Research on classroom and school climate. In D. Gabel (ed.), *Handbook of research on science teaching and learning* (p.493-541). New York: Macmillan.
- Fraser, B.J., & Walberg, H, J. (Eds) (1995). *Improving science education*. University of Chicago Press. Chicago: Society for the Study of Education.
- Fredua-Kwarteng, Y., & Ahia, F. (2005). *Ghana flunks at math and science: analysis (1 & 2). Feature Article*. Ghana News 23 February, 2005.
- Freire, P. (1985). *The politics of education: Culture, power and liberation*. (Donaldo Macedo, Trans.). South Hadley: Bergin and Garvey.
- Freire, P. (2000). *Pedagogy of the oppressed*. New York: The Continuum International Publishing Group Inc.
- Freire, P. (1999). *Pedagogy of hope: Reliving pedagogy of the oppressed*. New York: The Continuum Publishing Company.
- Galabawa, J.C.J. (1994). Status and future challenges of the Tanzania primary and secondary education. In L.A. Msambichaka, H.P.B. Moshi, & F.P. Mtatifikolo (Eds.), *Development challenges and strategies for Tanzania: An agenda for the 21st century* (pp. 291–306). Dar es Salaam: Dar es Salaam University Press.
- Garrison, J.W., & Bentley, M.L. (1990). Science education, conceptual change and breaking with everyday experience. *Studies in Philosophy and Education*, 10 (1), 19-35.
- Gay, G. (2000). *Culturally responsive teaching: Theory, research, & practice*. New York: Teachers College Press.
- Gideon, C. (2003). *Rorty and re-description*. London: Weidenfeld & Nicolson.

- Gluckman, P. (2011). *Looking ahead: Science education for the twenty-first Century: A Paper Commissioned by the Royal Society and the Prime Minister's Chief Science Advisor*. New Zealand Council for Educational Research.
- Goodrum, D., Hackling, M., & Rennie, L. (2001). *The status and quality of teaching and learning of science in Australian schools: A Research Report*. Canberra: Department of Education, Training and Youth Affairs.
- Goodman, R. (Ed) (2005). *Pragmatism: Critical concepts in philosophy*. London: Routledge.
- Gray, B. (1997). *Towards a more relevant and existing science curriculum: The trialling of the science through applications project curriculum materials: Paper Presented at the Fifth Annual Meeting of the Southern African Association for Research in Mathematics and Science Education*. Johannesburg, South Africa.
- Green, D. (1994). What is quality in higher education? Concepts, policy and practice, in Green, D. (Ed.). *What is quality in higher education?* SRHE and Open University Press, Buckingham.
- Greene, J.P. (2002). Mixed-method evaluation: a way of democratically engaging with difference. *Evaluation Journal of Australasia*, 2 (2), 23-29.
- Greene, J. P. (2005). *Education myths: What special-interest groups want you to believe about our schools and why it isn't so*. Lanham, MD: Rowman & Littlefield.
- Haack, S. (1997). Vulgar Rortyism. *New Criterion*, 16, (3), 67-70.
- Haack, S. (ed) (2006). *Pragmatism, old and new*. Amherst NY: Prometheus
- Hakielimu. (2007). *Redefine quality education in Tanzania: From input to capabilities: Working Paper*, October, 2007. Dar es salaam.
- Hakielimu, (2008). *What is quality education? A Research Report on Citizens' Perspectives and Children's Basic Skills*. Dar es Salaam: Hakielimu.
- Hamilton, M., Mahera, W. C., Mateng'e, M. F. J., & Machumu, M. M. (2010). *A Needs Assessment Study of Tanzania Science Education*. The economic and social research foundation (ESRF), Dar es Salaam.
- Hardman, F. (2014). Teacher education in sub-Saharan Africa: closer perspectives. Edited by R. Griffin. *British Journal of Educational Studies*, 62 (2), 217-219, DOI: 10.1080/00071005.2014.905309.

- Harris, K., & Jenz, F. (2006). The preparation of mathematics teachers in Australia: Meeting the demand for suitably qualified mathematics teachers in secondary schools. *Report Prepared for the Australian Council of Deans of Science*. Melbourne: Centre for the Study of Higher Education, the University of Melbourne.
- Harris, G., & Gates, H. (2014). The case for integrated health improvement. *NC Med J*, 75(6), 413-416.
- Harvey, L., & Green, D., (1993). Defining Quality. *Assessment and Evaluation in Higher Education*, 18, (1), 9–34.
- Harvey, L. (2002a). Evaluation for What? *Teaching in Higher Education*, 7(3), 245– 264.
- Hashweh, M. (2013). Pedagogical content knowledge: Twenty-five years later. *Advances in Research on Teaching*, 19, 115-140.
- Houston, D. J., (2008). Rethinking quality and improvement in higher education. *Quality Assurance in Education*, 16 (1), 61–79.
- Heneveld, W., & Craig, H. (1995). *Schools count: World Bank project designs and the quality of primary education in Sub-Saharan Africa*. Washington, DC: World Bank.
- Hestenes, D. (2013). Remodelling science education. *European Journal of Science and Mathematics Education*. 1 (1).
- Hipkins, R., Bolstad, R., Jones, A., Barker, M., Bell, B., Coll, R., Cooper, B., Forret, M., Harlow, A., Taylor, I., France, B., & Haigh, M.J. (2002). *Curriculum, learning and effective pedagogy: A literature review in science education*. Wellington: Ministry of Education.
- Hjørland, B. (2010). The foundation of the concept of relevance. *Journal of the American Society for Information Science and Technology*, 61, (2), 217-237.
- Hodson, D. (2011). *Looking to the future: Building a curriculum for social activism*. Rotterdam, the Netherlands: Sense Publishers.
- Hodson, D. (2014). Learning Science, Learning about Science, Doing Science: Different goals demand different learning methods. *International Journal of Science Education*, 36 (15), 2534-2553.
- Holt, M. (2000). *Introduction: The concept of quality in education, in improving quality in education*, C. Hoy, C. Bayne-Jardine, and M. Wood, Editors. Falmer: London.

- Holbrook, J. (2010). Education through science as a motivational innovation for education for all. *Science Education International*, 21(2), 80-91.
- ICASE. (2003). *Draft way forward document*. ICASE: Penang, Malaysia.
- Ikechi, K.S., & Akanwa, U.N (2012). Unethical practices in the Nigerian educational system. *Interdisciplinary Journal of Contemporary Research in Business*.4 (8).
- ILO, (2000). *Conclusions on lifelong learning in the twenty-first century: The changing roles of educational personnel, note on the proceedings*. Joint Meeting on Lifelong Learning in the Twenty-first Century, Geneva.
- International Technology Education Association (ITEA). (2000). *Standards for technological literacy: Content for the study of technology*. Reston, VA: ITEA.
- James, W. (1907). *Pragmatism: A new name for some old ways of thinking: Popular Lectures on Philosophy*. New York, Longmans, Green, and Co.
- Japanese International Cooperation Agency (JICA). (2009). *Baseline survey report from science teacher education project (STEPSAM2)*. Hiroshima University, 108p.
- Jay, P.G., & Marcus, A.W. (2005). *Education myths*. Rowman and Littlefield Publishers, Inc.
- Johnson, B., & Christensen, L. (2008). *Educational research: Quantitative, qualitative and mixed methods* (Third Edition). Thousand Oaks, CA: Sage.
- Johnson, R., & Onwuegbuzie, A. (2004). Mixed methods research: a research paradigm whose time has come. *Educational Researcher*. 33 (7) 14-26.
- Johnson, B., & Turner, L. A. (2003). Data collection strategies in mixed methods research. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (p. 297-319). Thousand Oaks, CA: Sage.
- Kalolo, J.F., & Kafanabo, E. (2012). Students' science knowledge as a constraint in developing interest in science studies among secondary school learners in Tanzania. *Journal of Education, Humanities and Sciences (JEHS)*. 1 (2). Dar es salaam university College of Education. Tanzania.

- Kalolo, J. F (2010). *School climate as a factor towards decline of interest in science studies among learners in secondary schools in Tanzania*. Unpublished Masters Dissertation, UDSM. Tanzania.
- Kember, D., & Mcnaught, C. (2007). *Enhancing university teaching: Lessons from research into award winning teachers*. Abingdon: Routledge.
- Khatib, M, Sarem, S.N., & Hamidi, H. (2013). Humanistic education: Concerns, implications and applications. *Journal of Language Teaching and Research*, 4, (1), 45-51.
- Kitta, S. (2004). *Enhancing mathematics teachers' pedagogical content knowledge and skills in Tanzania*. Doctoral dissertation. Enschede: University of Twente.
- King, D. T., & Ritchie, S. M. (2012). Learning science through real-world contexts. In B. J. Fraser, K. Tobin, & C. J. McRobbie (Eds.), *The international handbook of research in science education* (2nd ed., pp. 69–80). Dordrecht, Netherlands: Springer Press.
- King, N., & Horrocks, C. (2010). *Interviews in qualitative research*. Los Angeles: SAGE.
- Knamiller, G, W., Osaki, K.M., & Kuongl, H. (1995). Tanzania teachers' understanding of the science embedded in traditional technologies: A study to inform teacher education. *Research in Science and Technological Education*. 13 (1), 67-76.
- Knamiller, G.W. (1984). The struggle for relevance in science education in developing countries. *Studies in Science Education*. 11, 60-78.
- Knipprath, H. (2010). What PISA tells us about quality and inequality of Japanese education in mathematics and science. *International Journal of Science and Mathematics Education*, 9, 389-408.
- Kola, A. J. (2003). Uses of instructional materials for teaching and learning physics in Edu and Patigi local government areas, Nigeria. *International Journal of Research in Education*, 4(1 & 2), 74-79.
- Kola, A. J (2013). Importance of Science Education to National Development and Problems Militating Against Its Development. *American Journal of Educational Research*, 1 (7), 225-229.
- Kolstø, S. D. (2001). Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial socio scientific issues. *Science Education*, 85, 291-310.

- Komba, D. (2006). *Reflections on Mwalimu Nyerere's philosophy of education for self-reliance. A Paper Read at the International Seminar to Commemorate the 7th Anniversary of Mwalimu Nyerere*. Dar es Salaam. Faculty of Education. University of Dar es Salaam.
- Komba, W., & Nkumbi, E. (2008). Teacher Professional Development in Tanzania: Perceptions and Practices. *Journal of International Cooperation in Education*, 11 (3), 67-83.
- Krapp, A., & Prenzel, M. (2011). Research on interest in science: Theories, methods, and findings. *International Journal of Science Education*, 33 (1), 27-50.
- Krueger, R. A., & Casey, M.A. (2009). *Focus groups: A practical guide for applied research (4th Ed.)*. Thousand Oaks, CA: Sage Publications.
- Kubow, P. K., & Paul R. F. (2003). *Comparative education: Exploring issues in international context*. Upper Saddle River NJ: Merrill Prentice Hall.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Lederman, L. (2008). Science education and the future of humankind. *Science News*. 173 (16), 1.
- Levin, M., & Greenwood, D. (2011). Revitalizing university by reinventing the social sciences. In N. K. Denzin & Y. S. Lincoln (Eds.). *The sage handbook of qualitative research*, (4) 27-42). London, England: Sage.
- Levy, F., & Murnane, R. J. (2005). *The new division of labour: How computers are creating the next job market*. Princeton, NJ: Princeton University Press.
- Lewin, K. (1990). International perspectives on the development of science education: Food for thought. *Studies in Science Education*, 18, 1-23.
- Lindberg, D. C. (2010). *The beginnings of western science: the European scientific tradition in philosophical, religious, and institutional context, prehistory to AD 1450*. University of Chicago Press.
- Lockheed, M. E., & A. M. Verspoor (1991). *Improving primary education in developing countries*. Oxford, Oxford University Press for the World Bank.
- Lomas, L. (2002). Does the development of mass education necessary mean the end of quality? *Quality in Higher Education*, 8 (1), 71 – 79.

- Loughran, J., Mulhall, P., & Berry, A. (2004). In search of pedagogical content knowledge in science: Developing ways of articulating and documenting professional practice. *Journal of Research in Science Teaching*, 41(4), 370-391.
- Lovejoy, A. O. (1908). The thirteen pragmatisms. *The Journal of Philosophy*, 1, 5-12.
- Lyons, T. (2004). *Choosing physical science courses: The importance of cultural and social capital in the enrolment decisions of high achieving students: Paper Presented at the 11th Symposium of the International Organisation for Science and Technology Education (IOSTE)*, Lublin, Poland.
- Lebakeng, T. G. (2010). Discourse on Indigenous knowledge systems, sustainable Socio-economic development and the challenge of the academy in Africa. *CODESRIA Bulletin*, (1 & 2) 24-29.
- Maddock, M.N. (1981). Science education: An anthropological viewpoint. *Studies in Science Education*, 8, 1-26.
- Maddock, M. N. (1983). Research into attitudes and the science curriculum in Papua New Guinea. *Journal of Science and Mathematics Education in S.E. Asia*, 6 (1), 23-35.
- Magubane, Z. (2004). *Bringing the empire home: Race, class, and gender in Britain and colonial South Africa*. Chicago: University of Chicago Press.
- Mafumiko, F. (2004). *Micro-scale experimentation as a catalyst for improving the science curriculum in Tanzania*. Doctoral Thesis University of Twente. Enschede.
- Mahlaba, F. S. (2006). *An evaluation of the Gauteng department of education instrument for evaluating learning and teaching support materials (LTSM)*, Master's thesis, University of Johannesburg.
- Malekela, G. (2000). Quality of secondary school education in Tanzania. In J.C.J. Galabawa, F.M.K. Senkoro and A.F. Lwaitama (eds). *The quality of education in Tanzania: Issues and experiences*. Faculty of Education, University of Dar es Salaam.
- Malcolm, C. (1999). Inside the square and outside. *Studies in Science Education*, 33 (1), 134-140, DOI: 10.1080/03057269908560142.
- Maples, M. F. (1979). A humanistic education: Basic ingredients. *The Humanistic Educator*, 17(3), 137-151.

- Manathunga, C. (2007). "Unhomely" academic developer identities: more post-colonial explorations. *International Journal for Academic Development*, 12 (1), 25-34.
- Marcella, M., Kyalo, W.B., Kadenyi, M., & Kegode, G (2009). Myths in education: A Kenyan perspective. Moi University in Kenya. *Educational Research and Review*. 4 (3), 071-077,
- Marion, R., & Gonzales, L. D. (2013). *Leadership in education: Organizational theory for the practitioner*. Waveland Press.
- Martin, M.O., Mullis, I.V.S., Foy, P., & Stanco, G.M. (2012). *TIMSS 2011 international results in science*. Chestnut Hill, MA: Boston College
- Marsh, C. J., & Willis, G. (2003). Curriculum: Alternative approaches. *On-going Issues (3rd Ed.)*. Upper Saddle River, NJ: Pearson.
- Maxwell, J. A. (2008). *Designing a qualitative study*. Retrieved from http://www.corwin.com/upm-data/23772_Ch7.pdf on 22nd June 2013
- Mazama, A. (2001). The Afrocentric paradigm: Contours and definitions. *Journal of Black Studies*, 31(4), 387-405. Downloaded from jbs.sagepub.com at Victoria University of Wellington on March 20, 2014
- McKinley, E. (2007). Bodies of knowledge: narratives of colonialism, science and education. In Kenneth Tobin & Wolff-Michael Roth (eds.). *The culture of science education (p. 343-354)*. Rotterdam: Sense Publishers.
- McKinley, E., & Keegan, P.J. (2008). Curriculum and language in Aotearoa New Zealand: from science to pūtaiao. *L1 - Educational Studies in Language and Literature*, 8 (1), 135-147.
- McKinley, E., & Stewart, G. (2012). Out of place: Indigenous knowledge in the science curriculum. In *second international handbook of science education* (pp. 541-554). Springer Netherlands.
- McCLellan, J. A., & Dewey J. (1908). *The psychology of number and its applications to the methods of teaching arithmetic*. NewYork, D. Appleton.
- McLaren, P., & Farahmandpur, R. (2003). The globalization of capitalism and the new imperialism: notes towards a revolutionary critical pedagogy. In Carlson, D. and Dimitriadis, G. (Eds). *Promises to keep: Cultural studies, democratic education and public life (p.39-76)*. New York and London: Routledge Falmer.

- Michie, M. (2003). *The role of culture brokers in intercultural science education: A research proposal: Paper Presented at the Australasian Science Education Research Association Conference*, Melbourne, Australia.
- Middlecamp, C. (2008). *Chemistry in context: Evidence, goals, and gaps: Commissioned Paper*. In Promising Practices-Innovations in Undergraduate STEM Education, Board of Science Education. Washington, DC: The National Academies.
- Miles, M. B., & Huberman, M. A. (1994). *Qualitative data analysis: An expanded source book*. Thousand Oaks: Sage Publications.
- Millar, R., & Osborne, J. (1998). *Beyond 2000: Science education for the future: The Report of a Seminar Series Funded by the Nuffield Foundation*. London: King's College London, School of Education.
- Mishra, C. (2000). Humanistic approach to education. *Journal of NELTA*, 5 (2), 25-29.
- MOEVT. (2010). *Basic statistics in education*. Dar es Salaam: Ministry of Education and Culture. UNICEF, (2010). Statistics for United republic of Tanzania. Retrieved from http://www.unicef.org/infobycountry/tanzania_statistics.html#0 on 14th May, 2011.
- Ministry of Education and Vocational Training (MoEVT). (2007). *The annual Parliamentary budget report presented in the parliamentary meeting of the year 2007/2008*. Tanzania.
- Meena, W. E. (2009). *Curriculum innovation in teacher education*. Åbo Akademi University Press.
- Mkulo. M. (2011). *Country budget speech for the financial year 2011/2012*. Dar es salaam; Ministry of Finance.
- MOEC. (1999). *Education for all assessment: National report of the United Republic of Tanzania*. Dar es Salaam.
- Ministry of Education and Culture (MOEC). (2000). *Teacher education master plan*. URT: Dar es salaam.
- MoEC. (2008). *The development of education: National report of the United Republic of Tanzania: A Paper Presented at the 48th Session of International Conference on Education*. Geneva.
- MOEC. (2001). *Tanzania education status report*. URT: Dar es Salaam.

- MOEC. (2004a). *Joint review of the primary education development plan*. Dar es Salaam: United Republic of Tanzania.
- MOEC, (2009b). *A draft bill for providing registration, teaching profession, and establishment of teachers' professional board*. Dar es Salaam. Ministry of Education and Vocational Training.
- MoEC. (2004b). *Secondary education development plan*. Dar es Salaam: United Republic of Tanzania.
- MoEVT. (2009a). *Sera ya Elimu na Mafunzo 2009. Rasimu ya I. Toleo Jipya*, Juni, 2009.
- Moja, T. (2000). *Nigeria education sector analysis: An analytical synthesis of performance and main issues*, New York: World Bank
- Morgan, D. L. (2007). Paradigms lost and pragmatism regained. *Journal of Mixed Methods Research*, 1(1), 48-76. Doi: 10.1177/2345678906292462
- Mosha, H. J. (2000). Conceptualizing quality education. In J.C.J. Galabawa, F.M.K. Senkoro and A.F. Lwaitama (eds) *The quality of education in Tanzania: Issues and experiences*. Faculty of Education, University of Dar es Salaam.
- Mrutu, A., Ponera, G., & Nkumbi, E. (2005). *The SACMEC II project in Tanzania: A study of the conditions of schooling and the quality of education* (p. 198-201). Harare: SACMEQ.
- Mtika, P. D. G. (2008). *Teaching practice as a component of teacher education in Malawi: An activity theory perspective*. Nottingham: University Press.
- Mullis, I.V.S., Martin, M.O., Minnich, C.A., Stanco, G.M., Arora, A., Centurino, V.A.S., & Castle, C.E. (Eds.). (2012). *TIMSS 2011 encyclopedia: Education policy and curriculum in mathematics and science* (Vols. 1–2). Chestnut Hill, MA: Boston College.
- Munro, M., & Elsom, D. (2000). *Choosing Science at 16*. NICEC project report, NICEC, Cambridge.
- Mushashu, B.K. (1997). *Quality of education in public secondary schools: Major problems and solutions: Paper Presented at the Conference on Quality of Education in Tanzania*. Arusha. Tanzania
- Mushashu, B. (2000). The Issues of Quality of Public Secondary Schools: What ought to be done? In J.C.J. Galabawa, F.M.K. Senkoro and A.F. Lwaitama (eds). *The quality of education in Tanzania: Issues and experiences*. Faculty of Education, University of Dar es Salaam.

- Muskin, J.A. (1999). Including local priorities to assess school quality: The case of Save the Children Community schools in Mali. *Comparative Education Review*, 43(1), 36-63.
- Nanda, M. (2003). *Prophets facing backward: Postmodern critiques of science and Hindu nationalism in India*. Rutgers University Press.
- National Research Council. (1996). *National science education standards*. Washington, D.C: National Academy Press.
- NECTA. (2010). *Examination results statistic*. Dar es Salaam.
- NECTA. (2011). *Examination results statistic*. Dar es Salaam.
- Neuman, W. L. (2006). *Social research methods: Qualitative and quantitative approaches (6th ed.)*. Pearson.
- Newmann, F. M., & Associates. (1996). *Authentic achievement*. San Fransisco: CA: Jossey-Bass.
- Nikel, J., & Lowe, J. (2010). "Talking of fabric: a multi-dimensional model of quality in Education. *Compare: A Journal of Comparative and International Education*, 40 (5), 589-605.
- Ninnes, P., & Burnett, G. (2001). Postcolonial theory and science education: Textbooks, curriculum and cultural diversity in Aotearoa New Zealand. *New Zealand Journal of Educational Studies*, Te Hautaka Mātai Mātauranga, 36 (1), 25 - 39.
- Nyamnjoh, F. (2012). Potted plants in greenhouses: A critical reflection on the resilience of colonial education in Africa. *Journal of Asian and African Studies*, 1-26. Retrieved on 20th January 2014 from <http://jas.sagepub.com/content/early/2014/01/20/0021909611417240>.
- Nzeneri, I.S. (2010). Adults in Battle: Any Hope of Victory? *An Inaugural Lecture Series 71*, Presented to University of Port Harcourt.
- Odora-Hoppers, C. (2001). *Indigenous knowledge and the integration of knowledge systems: Towards a conceptual and methodological framework*. Pretoria: HSRC.
- OECD. (2003). *Education at a glance: OECD indicators*. Paris: OECD.
- OECD (2004). *Learning for tomorrow's world-First results from PISA 2003*. Paris: OECD.
- OECD. (2001). *Knowledge and skills for life: First results from PISA 2000*. Paris: OECD.

- Ogawa, M. (1986). Toward a new rationale of science education in a non-western society. *European Journal of Science Education*, 8 (2), 113-119.
- Ogawa, M. (2002). *Nature of indigenous science: A stratified and amalgamated model of knowledge and cosmology: Paper Presented to the 33rd Annual Meeting of the Australasian Science Education Research Association*, Townsville, Australia.
- Ogawa, M. (2008b). *Science education and education of indigenous science in the context of recent education reforms: Plenary lecture: International Academic Conference of Indigenous Science and Mathematics Education*, National Taitung University. Taitung, Taiwan.
- Ogunniyi, M. B. (1986). Two decades of science education in Africa. *Science Education*, 70 (2), 111–122.
- Ogunniyi, M. B. (1988). Adapting western science to traditional African culture. *International Journal of Science Education*, 10, 1-9.
- Ogunniyi, M. B. (1996). Science, technology and mathematics: the problem of developing critical human capital in Africa. *International Journal of Science Education*. 18 (3), 267-284.
- Ogunmade, O.T. (2005). *The status and quality of secondary science teaching and learning in Lagos State Nigeria*. PhD Thesis, Edith Cowan University, Perth Australia.
- Okeke, B.S. (2004). *Teaching in Nigeria: The bureaucracy and professionalism*. Enugu: Mercury Int'l publishing.
- Okoh, J.D. (2003). *Philosophy of education (the basics)*. Port Harcourt: Pearl Publishers.
- Omoke, C. M. (2011). *Quality of education offered to children with special educational needs (SEN) in the era of free primary education (FPE) in rural Kenya: Perspectives of educationists, teachers and parents*: Doctoral Thesis. Wellington: Victoria University of Wellington.
- Onwu, G. O. M., & Kyle, W. C., Jr. (2011). Increasing the socio-cultural relevance of science education for sustainable development. *African Journal of Research in Mathematics, Science and Technology Education*, 15 (3), 5–26.

- Onwuegbuzie, A.J., & Teddlie, C. (2003). A framework for analysing data in mixed methods research. In A Tashakkori & C Teddlie (Eds) *Handbook of mixed methods in social and behavioral research* (pp. 351-383) Thousand Oaks, CA: Sage.
- Onwuegbuzie, A.J., & Johnson, R.B. (2006). The validity issues in mixed research. *Research in Schools*, 13 (1), 48-63.
- Organisation for Economic Co-operation and Development {OECD} (2007). *PISA 2006: Science competencies for tomorrow's world* (vol. 1). Paris: OECD.
- Organisation for Economic Co-operation and Development –Global Science Forum-OECD-GSF. (2006). *Evolution of student interest in science and technology studies policy report*. OECD: Paris.
- Osaki, K. (1994). *Indigenous African knowledge, understanding the use and Misuse: A Paper Presented at Pan African Colloquium on Education Innovations in Post-colonial Africa*. Cape Town.
- Osaki, K. (1995). *Issues in teaching and learning of science in Tanzania*. Unpublished paper UDSM.
- Osaki, K. M. (2000a). *Quality education in Tanzania: A focus on standards in the secondary education sector. Paper Presented at the Annual Headmasters' Conference Held at Arusha, Tanzania*.
- Osaki, K. M. (2000b). Reflections on the State of Science education in Tanzania. In K. Osaki, K. Hosea & W. Ottevanger (Eds.), *Reforming science and mathematics education in Sub-Saharan Africa* (pp.11-26). Amsterdam: Vrije Universteit Amsterdam.
- Osaki, K., Ottevanger, W., Uiso, C., & van den Akker. J. (Eds.) (2002). *Science education research and teacher development in Tanzania*. Amsterdam: Vrije Universiteit.
- Osaki, K. (2002). *Science education research and teacher development in Tanzania*. Amsterdam. VrijeUniversiteit Printers.
- Osaki, K., Hosea, K., & Ottevanger, W. (Eds.) (2004). *Reforming science and mathematics education in Sub-Saharan Africa: Obstacles and opportunities*. Dar es Salaam: TEAMS, University of Dar es Salaam.

- Osaki, K.M. (2004a). Reflections on the state of science education in Tanzania. In Osaki K.M. Hosea, K, Ogevanger, W.J.W (eds). *Reforming science and mathematics education in Sub Saharan Africa. Obstacles, opportunities*. Dar es Salaam & Euschede. TEAMS Project.
- Osaki, K. (2004b). Tanzania: reflections on the secondary education analysis and secondary education development programme: *Paper Presented at the World Bank Conference on Secondary Education in Africa*, Dakar, 6-9 June 2004.
- Osaki, K., & Njabili, A. (2003). *Secondary education sector analysis: Report to the Ministry of Education and Culture and World Bank*. Tanzania: Dar es Salaam.
- Osaki, K.M., & Tilya, F. (Eds.) (2004c). *Science and Maths Education Publication Series No.1*. Dar es Salaam: University of Dar es Salaam.
- Osaki, K. M. (2005). Reflections on the medium of instruction and interaction: A focus on science teaching and learning. In B. Brock-Utne, Z. Desai, & M. Qorro *LOITASA (Language of Instruction in Tanzania and South Africa) research in progress*. Dar es Salaam: KAD Associates.
- Osaki, K.M. (2007). The challenge of science and mathematics education in Tanzania. *Paper Presented at the Workshop to Launch the National Science INSET Programme*. Dar es Salaam: Ministry of Education and Vocational Training.
- Osborne, J., Duschl, R., & Fairbrother, B. (2002). *Breaking the mould? Teaching science for public understanding*. School of Education, King's College London.
- Osborne, J. (2006). *Communicating science: A BAI round table summary*. The Centre for Informal Learning and Schools. Retrieved on 24th August 2012 from www.exploratorium.edu/cils/documents/RTcommunicationJO.pdf
- Osborne, J., & Dillon, J. (2008). *Science education in Europe: Critical reflections*. A Report to the Nuffield Foundation. Retrived from, http://www.nuffieldfoundation.org/fileLibrary/pdf/Sci_Ed_in_Europe_Report_Final.pdf on 1st March. 2011.
- O'Sullivan, M. (2006). Lesson observation and quality in primary education as contextual teaching and learning processes. *International Journal of Educational Devleopment*, 26, 246-260.

- Ottevanger, W., Osaki, K., & van den Akker, J. (2005). The TEAMS Project in Tanzania: From Intervention to Capacity Building. CICE Hiroshima University, *Journal of International Cooperation in Education*, 8, (1) 111-123.
- Pallant, J. (2005). *SPSS survival manual: A step guide to data analysis using SPSS for windows (Version 12)*. New York (2nded.). Open University Press.
- Patton, M. Q. (2002). *Qualitative evaluation and research methods* (3rded.) Thousand Oaks, CA: Sage.
- Peirce, C. S. (1992). *The essential Peirce: Selected philosophical writings*, Vol.1. (Indianapolis, IN, Indiana University Press).
- Penn, H. (1997). Inclusivity and diversity in early childhood services in South Africa. *International Journal of Inclusive Education*, 1(1), 101-114.
- Petrou, M. (2007). *Teachers' mathematics content knowledge: Paper Presented at the European Research in Mathematics Education*, Larnaca, Cyprus. Retrieved from http://ermeweb.free.fr/CERME%205/WG11/11_Petrou.pdf on 23 march 2013.
- Pigozzi, M. J. (2006). What is the Quality of Education? A UNESCO perspective. In *Cross-national studies of the quality of education: Planning their design and managing their impact* (p. 39-49). Eds. Kenneth N. Ross and Ilona Genevois. Paris, UNESCO-IIEP, 2004.
- Porter, C., & Parvin, J. (2009). *Learning to love science: Harnessing children's scientific imagination*. A report from the Chemical Industry Education Centre, University of York. Retrieved August 5, 2012, from http://www-static.shell.com/static/gbr/downloads/responsible_energy/ro1427_ses_report.pdf
- Pratt, S. (2002). *Native pragmatism: Rethinking the roots of American philosophy*. Indiana University Press: Indianapolis, IN.
- Prather, J. P. (1990). *Tracing science teaching*. Washington, DC: National Science Teachers Association.
- Punch, K. F. (2005). *Introduction to social research: Quantitative and qualitative approaches*. London: SAGE.

- Qorro, M. (2004). Popularising Kiswahili as the language of instruction through the media in Tanzania. In B. Brock-Utne, Desai, Z. & Qorro, M. (2004). *Researching the language of instruction in Tanzania and South Africa*. African minds. Cape Town: One world books.
- Qorro, M. (2006). Does Language of Instruction Affect Quality of Education? A Paper presented at the monthly 0730 people and policy debates jointly organized by Hakielimu and policy forum in Tanzania.
- Rajani, R., & Sumra, S. (2003). Is extra funding for primary education making a difference? Conceptual and measurement challenges. *Hakielimu Working Paper Series No.3*, Tanzania Hakielimu.
- Ramose, M.B. (1999). *African philosophy through Ubuntu*. Harare: Mond Books.
- Reed, R, F., & Johnson, T, W. (2000). *Philosophical documents in education*. New York: Addison-Wesley.
- Reddy, V. (2006). Challenges to meet international Maths and Science standards, *HSRC Review*, 4(1).
- Reddy, V (Ed). (2006b). Mathematics and Science Achievement at South African Schools in TIMSS 2003. Cape Town: HSRC Press.
- Rennie, L. J., & Parker, L. H. (2000). *Toward quality in assessment practice in Schools: Paper Presented at the Annual Meeting of the American Educational Research Association*, New Orleans, LA.
- Rescher, N. (2000). *Realistic pragmatism*. Albany: SUNY Press.
- Reys, B. J., & Reys, R. E. (2006). The development and publication of Elementary Mathematics textbooks: Let the buyer beware! *Phi Delta Kappan* 87(5), 377–383. Accessed on 12th Sept 2012 from http://goliath.ecnext.com/coms2/gi_0199-5400851/The-development-and-pub%lication-of.html.
- Richards, H., & Schwartz, L. (2002). Ethics of qualitative research: Are there special issues for health research? *Family Practice*, 19 (2), 135-139.
- Robert, B. (ed). (2000). *Rorty and his critics*. Oxford: Blackwell Publishing.
- Rorty, R. (2004). Pragmatism. In *Routledge Encyclopedia of Philosophy*. London: Routledge.
- Roskelly, H., & Kate, R. (1998). *Reason to believe: Romanticism, pragmatism, and the teaching of writing*. Albany: Suny Press.

- Rosamond, B. (2007). The political sciences of European integration: disciplinary history and EU studies. In K. E. Jørgensen, M. A. Pollack & B. Rosamond (Eds.). *The SAGE handbook of European Union politics*. London: Sage.
- Rosenthal, S. B., & Thayer, H. S. (2011). Pragmatism. In *Encyclopædia Britannica*. Retrieved on 23rd June, 2011 from <http://www.britannica.com/EBchecked/topic/473717/pragmatism>.
- Rose, J. (2006). *Independent review of the teaching of early reading: Final report the rose review*. London: Department for Education and Skills (DfES). Accessed on 24th Jan 2013 from <http://www.standards.dfes.gov.uk/rosereview/>.
- Roth, W.M., & Lee, S. (2004). Science Education as/for Participation in the Community. *Science Education*, 88 (2), 263-291.
- Roy-Campbell, Z. M., & Qorro, M. (1997). *The language crisis in Tanzania: The myth of English versus education*, DSM: Mkuki na Nyota Publishers.
- Rubin, H. J., & Rubin, I. S. (2005). *Qualitative interviewing: The art of hearing data* (2nded.). Thousand Oaks, CA: Sage.
- Ryan, A. (2008). Indigenous knowledge in the science curriculum: Avoiding neo-colonialism. *Cultural Studies of Science Education*, 3 (3), 663–702.
- Ryder, J. (2001). Identifying science understanding for functional scientific literacy. *Studies in Science Education*. 36, 1-44.
- Ryen, A. (2004). Ethical issues. In C. Seale, G. Gobo, J. Gubrium & D. Silverman (Eds.). *Qualitative research practice* (pp. 217-219). London: Sage Publications.
- SACMEQ. (2005). Malawi Report: “The SACMEQ II Project in Malawi: A Study of the Conditions of Schooling and the Quality of Education. *Malawi working report*.
- Sallis, E. (2002). *Total quality management in education*. Psychology Press.
- Samoff, J., & Carrol, B. (2004a). Conditions, coalitions and influence: The World Bank and higher education in Africa. *Paper presented at the Annual Conference of the Comparative and International Education Society*, Salt Lake City.
- Saunders, W. (1992). The constructivist perspective: Implications and teaching strategies for science. *School Science and Mathematics*, 93 (3), 136–141.

- Scheerens, J. (2000). Improving School Effectiveness. Paris, UNESCO: International Institute for Educational Planning. *Fundamentals of Educational Planning*. 68, 18 – 31
- Scheerens, J. (2002). School self-evaluation: Origins, definition, approaches, methods and implementation. In D. Nevo (Ed.), *School-based evaluation: An international perspective* (pp. 35–73). Oxford: Elsevier Science
- Schreiner, C., & Sjøberg, S. (2004). *Rose - The relevance of science education*. (4). Oslo: ILS.
- Sjøberg, S. (2002). Science for the children? Report from the Science and Scientists project, *Acta Didactica*.1, (4–42). Oslo: Dept. of Teacher Education and School Development, University of Oslo.
- Sjøberg, S., & Schreiner, C. (2005). How do learners in different cultures relate to science and technology? Results and perspectives from the project ROSE. *Asia-Pacific Forum on Science Learning and Teaching*, 6 (2), 1-17.
- Sjøberg, S., & Schreiner, C. (2010). *The ROSE project: An overview and key findings*. University of Oslo.
http://folk.uio.no/sveinsj/ROSE-overview_Sjoberg_Schreiner_2010.pdf.
- Seltzer-Kelly, D. (2008). Deweyan Darwinism for the Twenty-first Century: Toward an educational method for critical democratic engagement in the era of the institute of education sciences, *Educational Theory*, 58 (3), 289–304.
- Singh, Y. K. (2007). *Philosophical foundation of education*. New Delhi: A P H Publishing.
- Silverman, D. (2006). *Interpreting qualitative data* (3rd Ed.). London: Sage Publications.
- Sifuna, D. (2007). The challenges of increasing access and improving quality: An analysis of Universal Primary Education intervention in Kenya and Tanzania since 1970s. *International Review of Education*, 53, 687– 699.
- Sleeper, R.W. (2001). *The necessity of pragmatism: John Dewey's conception of philosophy*. Urbana, IL, University of Illinois Press.
- Smith, S. C., & Piele, P. K. (1989). *School leadership: Handbook for excellence* (2nd Ed). Oregon: ERIC Clearing house for Educational Management.

- Smolicz, J.J., & Nunan, E. E. (1975). The philosophical and sociological foundations of science education: The demythologizing of school science. *Studies in Science Education*, 2, (101- 143).
- Snively, G. (1995). Bridging traditional science and western science in the multicultural classroom. In G. Snively and A. MacKinnon (eds.), *Thinking globally about mathematics and science education* (p.53-75). Vancouver, BC: Centre for the study of curriculum and instruction, University of British Columbia.
- Snively, G., & Corsiglia, J. (2001). Discovering indigenous science: Implications for science education. *Science Education*, 85 (1), 6–34.
- Spencer, L.M, Schooley, M.W, Anderson, L. A, Kochtitzky, C.S, DeGroff, A.S, Devlin, H.M et al. (2013). Seeking best practices: a conceptual framework for planning and improving evidence-based practices. *Prev Chronic Dis*, 10, 130-186. Retrieved from http://www.cdc.gov/pcd/issues/2013/13_0186.htm on August 30, 2014.
- Srikanthan, G., & Dalrymple, J. (2003). Developing alternative perspectives for quality in higher education. *The International Journal of Educational Management*, 17 (3), 126-36.
- Stanley, M. (2007). *Practical mystic: Religion, science, and A.S. Eddington*. Chicago and London: University of Chicago Press.
- Stanley, W. B., & Brickhouse, N.W. (2001). Teaching sciences: The multicultural question revisited. *Science Education*, 85 (1), 35–49.
- Stensaker, B. (2007). *Impact of quality processes: Embedding quality culture in higher education: Selected Papers from the 1st European Forum for Quality Assurance 2007*. Retrieved on 22nd November 2012 from www.eua.be/fileadmin/user_upload/files/Publications/EUA_QA_Forum_publication.pdf
- Stewart, D.W., Shamdasani, P.N., & Rook, D.W. (2007). *Focus groups: Theory and practice*, 2nd edition. Thousand Oaks, CA: Sage
- Stewart, G. M. (2007). *Kaupapa Māori science*. Unpublished doctoral dissertation, The University of Waikato.
- Stewart, V. (2010). A classroom as wide as the world. In *Curriculum 21: Essential education for a changing world*, ed. H. Hayes Jacobs (p.97–114). Alexandria, VA: Association for Supervision and Curriculum Development.

- Stoll, C., de Feiter, L., Vonk, H., & van den Akker, J. (Eds.). (1996). *Improving science and mathematics teaching in Southern Africa: Effectiveness of interventions*. Amsterdam: VU University Press.
- Stronkhorst, R. (2001). *Improving science education in Swaziland*. Doctoral dissertation. Enschede: University of Twente,
- Stumpf, S.E., & Fieser, J. (2008). *Socrates to Sartre and beyond: A history of philosophy*. New York: McGraw-Hill.
- Sumra, S., & Rajani, R. (2006). Secondary education in Tanzania: Key policy Challenges. *Working paper on the Norwegian post- primary education fund for East Africa (NPEF)*, Oslo.
- Switzer, T. J., Callahan, W. P., & Quinn, L. (1999). *Technology as facilitator of an unfinished model: Paper presented at Society of Information Technology and Teacher Education*. San Antonio.
- Symington, D., & Tytler, R. (2005). Designs on science: intelligent design merits intelligent debate in schools. *Australian (Canberra, A.C.T.)*. Nationwide News Pty Limited, Canberra, A.C.T.
- Taatila, V., & Raij, K. (2012). Philosophical review of pragmatism as a basis for learning by developing pedagogy. *Educational Philosophy and Theory*, 44 (8), 831-844.
- TEN/MET., & Oxfam. (2006). *Quality education conference Kunduchi declaration*. Dar es Salaam: TEN/MET/Oxfam.
- TEN/MET. (2007). *Report on critical issues and challenges in secondary education in Tanzania: Study conducted by the Bureau of Education Research and Evaluation*. Faculty of Education. University of Dar es Salaam.
- Teddlie, C., & Tashakkori, A. (2003). Major issues and controversies in the use of mixed methods in the social and behavioral sciences. In Tashakkori & Teddlie (Eds.) *Handbook of mixed methods in social and behavioral research* (Chapter 1). Thousand Oaks, CA: Sage Publications.
- Tikly, L. (2010). A roadblock to social justice? An analysis and critique of the South African education Roadmap. *International Journal of Educational Development* 31(1), 86-94.
- Tikly, L., & Barrett, A.M. (2007). *Education quality. Research priorities and approaches in the global era*. Bristol: University of Bristol.

- Tillman, L. C. (2002). Culturally Sensitive Research Approaches: An African-American Perspective. *Educational Researcher*, 31 (9), 3-12.
- Tröhler, D., & Oelkers, J. (Eds.). (2005). *Pragmatism and education*. Rotterdam: Sense Publishers.
- Thomas, H. (2003). The arguments for and the meaning of quality. *ELT Journal*. 57(3), 234 – 241.
- Tuckett, A. G. (2005). Applying thematic analysis theory to practice: A researcher's experience. *Contemporary Nurse*, 19(1-2), 75-87
- Tytler, R. (2007). *Re-imagining science education – engaging students in science for Australia's future*. Camberwell Vic: Australian Council for Educational.Cultural discontinuity: Toward a quantitative investigation of a major hypothesis in education. *Educational Researcher*, 37 (5), 280–297.
- UNESCO Regional Bureau for Education in Africa. (2003). Education for all in Africa bulletin, *Technical report*, UNESCO. Accessed on 16th March, 2012 from: http://www.dakar.unesco.org/efa/bulletin/index_en.shtml.
- UNESCO. (2005). *EFA global monitoring report 2005: Education for all, the quality imperative*. Paris: UNESCO.
- UNESCO. (2006). *Guidelines for quality provision in cross-border higher education*. UNESCO Paris. France.
- UNESCO. (2008). *The global literacy challenge*. Paris, UNESCO.
- UNESCO. (2007). *Quality education for all: A human rights' issue: Background document for the Second Meeting of the Intergovernmental Committee of the Regional Education Project for Latin America and the Caribbean–PRELAC* (UNESCO; Santiago).
- UNESCO. (2002). *EFA global monitoring report 2002: Is the world on track?* Paris: UNESCO.
- UNESCO. (2004). Education for All, the Quality Imperative. *EFA global monitoring report 2005*. Paris, UNESCO.
- UNICEF. (2000). *Defining Quality in Education: A Paper Presented by UNICEF at the Meeting of the International Working Group on Education*. Florence, Italy
- UNICEF. (2007). *Characteristics of a rights-based child friendly school checklist*. Accessed from: www.unicef.org/lifeskills/files/CFSChecklist.docS on 22nd March, 2014.

- UNICEF. (2009). *Child friendly schools*. New York: UNICEF.
- United Republic of Tanzania (URT). (1995). *Education and training policy*. Ministry of Education Culture, Dar Es Salaam.
- United Republic of Tanzania (URT), (1996). *National science and technology policy*. Dar es Salaam. MoEC.
- URT. (2007). *The Tanzania national ICT policy for basic education*. United Republic of Tanzania.
- URT. (1998). *Tanzania development vision 2025*. Dar es Salaam: URT.
- URT. (2001a). *Education sector development programme: SEDP (2006 -2000)*. Basic development Committee. Dar es Salaam.
- URT (2001b). *Teacher education master plan*. Dar es Salaam: URT.
- URT. (2006). *Primary education development program II (2007-2011)*. Education and Training Sector Development Programme (ETSDP). Ministry of Education and Vocational Training (MoEVT).
- URT. (2010a). *A general report of the controller and auditor general on the performance audit (vfm) reports for the period ending 31st march, 2010*. United Republic of Tanzania.
- URT. (2010b). *Speech by the minister of education and vocational training Hon. Professor Jumanne Maghembe (Mp) for the financial year 2010/2011*, Dar es Salaam, Dar es Salaam: MoE.
- URT. (2010c). *Education sector performance report of 2010*. Education Sector Development Programme 2009/2010 Report. United Republic of Tanzania.
- URT. (2009). *Basic education statistics in Tanzania (BEST)*. National Data. Dar es salaam. Ministry of Education and Culture.
- URT. (2012). *The 2012 population and housing census*. Dar es Salaam: Central census office, national bureau of statistics. Tanzania.
- Uwezo, (2010). *Are our children learning? Annual learning assessment report*. Tanzania.
- Van Eijck, M., & Roth, W.M. (2007). Improving science education for sustainable development. *PLoS Biol*, 5 (12).
- Vavrus, F. (2009). The cultural politics of constructivist pedagogies: Teacher education reform in the United Republic of Tanzania. *International Journal of Educational Development*, 29 (3), 303-311

- Vendlinski, T. P., Nagashima, S., & Herman, J. L. (2007). Creating accurate science benchmark assessments to inform instruction. *CSE technical report 730*. CRESST/University of California, Los Angeles
- Vuzo, M. (2005). *Using English as a medium of instruction in Tanzania secondary schools: Problems and prospects*. In Brock-Utne, Desai and Qorro (eds.): LOITASA Research in Progress Dar es Salaam: KAD Associates.
- Weaver, N. E (2011). *Educational policy in Tanzania from independence to the present: Continuity and transformation*. Undergraduate Thesis, University of Pittsburgh.
- Wedgwood, R. (2007). Education and poverty reduction in Tanzania. *International Journal of Educational Development*, 27(4), 383-396.
- White, C., Woodfield, K., Ritchie, J. (2003). Reporting and presenting qualitative data. In: Ritchie J, Lewis J, eds. *Qualitative Research Practice: A guide for social science students and researchers*, (287-320). London: Sage.
- Wiersma, W., & Jurs, S.G (2005). *Research methods in education: An introduction*. Boston: Pearson.
- Wilmarth, S. (2010). Five socio-technology trends that change everything in learning and teaching. In *Curriculum 21: Essential education for a changing world*, ed. Heidi Hayes Jacobs (p.80–96). Alexandria, VA: Association for Supervision and Curriculum Development.
- Wilson, B.J. (1981). The cultural contexts of science and mathematics education: Preparation of a bibliographic guide. *Studies in Science Education*, 8, 27-44.
- Windschitl, M. (2009). Cultivating 21st century skills in science learners: How systems of teacher preparation and professional development will have to evolve. *Presentation given at the national academies of science workshop on 21st century skills*, Washington, DC.
- Woodbridge, F. (1904). Field of Logic. *Science. New Series*, 20, (514), 587-600.
- World Bank. (2005). *Expanding opportunities and building competencies for young people: A new agenda for secondary education*. Washington, D.C.: The World Bank.
- World Bank. (2007). *Recruiting, retaining, and retraining secondary school teachers and principals in Sub-Saharan Africa*. Washington, D.C.: The World Bank.

- World Bank. (2011). A Regional Exploration of Pathways toward Harmonization of Math & Science Curriculum in the East African Community. *Discussion paper*.
- Yin, K. R. (2009). *Case Study Research: Design and Methods* (4thed). Thousand Oaks, CA: Sage.

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APPENDICES

APPENDIX A

Guiding Interview Questions for Science Alumni and Parent Association Staff

1. In your view, what does quality science education mean to you?
2. In your opinion, what are the desirable features for quality SE in Junior secondary schools?
3. How would you describe the current efforts towards quality SE in Tanzanian secondary schools?
4. What are the strengths and weaknesses of the contemporary SE in Tanzanian secondary schools?
5. In your own view, do the contemporary SE practices explain Tanzanian challenges and if not, why?
6. What has been missing in science education that you think is essential for achieving quality science education?
7. What do you think are the most important challenging aspects to the current science education and why?
8. In your opinion, what are the main priorities to consider in the future efforts towards achieving quality science education?
9. What do you think Tanzania can and should learn from developed countries when it comes to provision of quality SE?
10. Do you have any other comments about how to improve quality SE in Tanzanian secondary schools?

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APPENDIX B

Guide Interview Questions for Heads of Schools

1. In your opinion how would you describe quality science education in secondary schools today?
2. What do you think are the desirable features for quality SE in JSS?
3. Looking at the current SE practices in secondary schools today do you think we are in the right track towards delivery of quality SE?
4. Do you think is worthy learning from other countries about how to deliver quality SE in schools? What specifically can be learnt?
5. What do you think should be the major characteristics of quality science education in Tanzanian secondary schools?
6. In your view what are the strengths and weaknesses of the contemporary science education in today's secondary schools?
7. What factors do you think limit the delivery of quality science lessons in your school?
8. What can be done as remedial measures towards delivering quality science education in secondary schools?
9. Do you have anything to add about improving SE apart from what we have discussed?

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APPENDIX C

Guide Questions for the Focus Group Discussion with Students

1. Are you happy with the way science subjects are taught in your school?
Explain your answer.
2. What things do you really like and/or dislike about science subjects in your class and why?
3. What do you think are the desirable features for quality SE?
4. What discourages you about learning science in your school?
5. What do you think might be missing from your current SE and why?
6. What do you consider to be the major challenges for you to have quality science education in your schools?
7. How do you think science subjects could be improved to help you learn better?
8. Can you think of some more ways to improve science education in your school?
9. What do you think we can learn from other schools (inside and outside the country) in terms of delivery of quality SE in schools?
10. Do you have anything to share with us about improving science education in schools, apart from what we have discussed?

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APPENDIX D

Guide Interview Questions for the Staff from the National Examination Council of Tanzania

1. How would you describe the quality of science education in today's Tanzanian secondary schools?
2. Are you comfortable with the way science education is enacted in today's science classrooms? Explain your answer.
3. What are the strengths and weaknesses of the contemporary SE in Tanzanian secondary schools?
4. In your view what do you consider are the desirable features for quality SE?
5. In view of the way SE is practised in today's schools, what do you think needs to change and why?
6. What role does your department play in ensuring that there is quality delivery of science education in secondary schools?
7. What competencies do you consider worth measuring in science education and they are missing in the current school science education practices?
8. What are the main challenges that your department consider important to be addressed towards achieving quality and relevant science education in schools?
9. In your view what can we do to be able to address the contemporary challenges in SE?
10. Do you have anything to add about improving science education in schools apart from what we have discussed?

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APPENDIX E

Questionnaire Questions for Teachers

1. In your opinion is it necessary for students to acquire quality science education in schools?

YES ☐

☐ NO

Give reasons for your answer

.....
.....

2. Are the objectives and requirements of science courses reflecting the job needs and demands? NO ☐ YES ☐

In the categories below put a tick (✓) against a correct response which is reflected by the science Studies.

a) Academic needs only	☐
b) Job needs only	☐
c) Both academic and job needs	☐
d) Both academic needs and some job needs	☐
e) Others	

(mention).....

.....

3. Do you engage yourself in any quality science education related professional programmes?

NO ☐

YES ☐

If yes, please mention any of the programmes attended

.....
.....

4. Do you think the science policies that are currently operating in the country are effective towards relevant SE in schools

NO ☐

YES ☐

If NO, what do you think they should address?

.....

5. How long have you been teaching science in secondary schools?

1-2 years ☐

3-6 years ☐

more than 7years ☐

Use the scales given to decide on your response. "The key for question 6.

SA	A	U	D	SD
Strongly agree	Agree	Undecided	Disagree	Strongly disagree

6. The extent to which the science studies taught in schools are linked to the purpose of developing interest among learners to learn them

S/No.	Items	SA	A	U	D	SD
i	Students are ignorant of the science subjects					
ii	The subjects are very difficult					
iii	Students do not easily understand the subjects					
iv	The science subjects are foreign to the students					
v	Most of science topics taught are irrelevant to the students' needs and the community they live in					
vi	Teachers are not competent enough to teach science subjects					
vii	Schools are not supplied with necessary instructional materials such as books, chemicals, laboratory facilities, or radio and visual aids					
viii	The subjects as disciplines hardly have a direct link which can be found easily by students after their school studies					
ix	The language of instruction is foreign to students and difficult to use and master the subjects with ease					
x	There are poor methods for learning science studies as it is theory –based					
xi	The time on task scheduled for these subjects is very minimal					
xii	Science national examinations sometimes measure what students have never learned					
xii	The courses in science have good future prospects					

7. 11. What efforts do you take to enable your students to understand the lesson and manage their learning problems? Put a tick (✓) for your correct response(s)
- a) Being available for consultation after a lesson..... ☐
 - b) Encouraging the students asking/discussing with friends the areas of difficult..... ☐
 - c) Asking the students to read the notes..... ☐
 - d) Conducting tuition..... ☐
 - e) Preparing the remedial classes..... ☐
 - f) Making available all the necessary textbooks and the reference books For science..... ☐
 - g) Orienting the students towards becoming problem solvers through many experiments ☐
 - h) Others (Specify)..... ☐
8. In what ways have you been accountable for your students learning in science?.....
.....
.....
9. In your view, how would you describe quality science education for Tanzanian students in secondary schools?
.....
.....
.....
10. What do you think are the challenges in contemporary efforts to the deliver quality and relevant science lessons?.....
.....
.....
11. What can you say about the power of the contemporary SE to respond to the current cross cutting issues and the global challenges in the modern Tanzanian life?.....
.....
.....
.....

12. In your professional experience, do you see any difference between the current SE and the previous one? Are there any reasons behind their difference?.....

13. In the view of modern life challenges do you think is necessary for Tanzanian science education to change? What specific changes would you suggest? ...

14. Do you think there is a need to learn from other countries' science education frameworks? In which specific aspects?

15. In your own view what are the prevailing and emerging issues in science education that need to be addressed in Tanzania SE system?.....

16. There has been a strong push from the Tanzanian government that, schools should to deliver quality science education. What are the strengths and weaknesses towards this achievement?.....

17. As a science teacher, do you think you are given enough chance to make science learning fascinating in today's classrooms?.....

.....
.....
.....
.....

18. What do you foresee regarding the current progress of SE in Tanzanian secondary schools?.....

.....
.....
.....

19. Do you have anything to add apart from what we have discussed?

.....
.....
.....

Thank you for your cooperation.

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APPENDIX F: Guide Interview Questions for the Staff from Tanzania
Institute of Education

1. What does quality science education in today's secondary schools mean to you?
2. In view of the current quality of science education in schools, what are the strengths and weaknesses to be considered?
3. In view of the current life challenges, what would you suggest to be the characteristics or rather structure of science education in Tanzanian secondary schools?
4. In your opinion what do you consider as being the desirable features for quality SE?
5. What standards do your institute work to attain especially in delivery of quality science education and how do you work towards attaining them in schools?
6. How has your office been working towards quality science education in schools?
7. Do you think there is any need for the Tanzanian secondary schools to learn from other countries on how to best deliver quality science education? Which specific aspects can be learnt?
8. On the way towards providing and maintaining high quality science education programs what challenges do you face? And what do you think is the nature of those challenges?
9. What approach can be used to address the challenges in school's science education?
10. What is missing in today's SE and you think if such thing(s) is/are addressed Tanzania will achieve quality SE in secondary schools?
11. Apart from what we have discussed, is there anything that you want to add about improving science education in schools?

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APPENDIX G

**Guide Interview Questions for the District Educational Officer and a Staff
from Ministry of Science and Technology**

1. In your view how would you describe quality SE?
2. In your personal opinion how would you describe quality science education in Tanzanian secondary schools today?
3. In your opinion how do you describe as being the desirable features for quality SE?
4. In your own view what contributes to the today's science education and what would be most ideal situation which you would like?
5. How is your office strategizing towards ensuring delivery of quality science education in secondary schools?
6. Do you think there is any need to learn from other countries on how they are doing in enhancing the quality of science education? What can be learnt specifically?
7. What do you consider as basic characteristics of quality science education in Tanzanian secondary schools and they are missing?
8. In your own view can you see any strength and weakness of science education in today's schools? What are they?
9. What factors do you think limit the delivery of quality and relevant science lessons in our schools?
10. What can we do as remedial measures towards quality science education in secondary schools?
11. Do you have anything to add about improving science education apart from what we have discussed?

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APPENDIX H

Guide Questions for Reviewing the Documents

1. What are the general trends of the current SE initiatives towards quality and relevant science education?
2. How the documents are articulate the ideal features for quality SE?
3. What are the goals of science education and to what extent do they reflect the changing world of science learning?
4. What are the current dynamics of the current science education that redefine our practices in secondary schools today?
5. What is the current structure and characteristics of science education that is more preferred for effective science literacy in schools?
6. What philosophy governs the science education in the world and how can it be explained in the context of Tanzania.
7. What are the current issues in science education today? And what is the best way to address those issues?
8. What can be learnt from other countries in terms of standard practices for science education in secondary schools?
9. What is something important but not widely known or well understood about Quality SE in Tanzania?

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APPENDIX I: Respondents' follow up questionnaire

In Table 1, 2, 3, & 4 Use the scales given to decide on your response by putting √ sign in the boxes provided against each phrase.

Table 1: The meaning about quality SE

C/N	SITES			
	CASE			
	Quality science education can be defined in terms of the following aspects:	Responses in %		
		Agree	Not sure	Disagree
1	Meeting stakeholders expectations			
2	Development of students potentials			
3	Providing students with quality school experiences			
4	Provision of good learning support services			
5	Determinant of the learners' future life			
6	Achievement of good grades in the final exams			
7	Development of survival skills among learners			

Table 2: Desirable features for quality SE

C/ N	SITE			
	CASE			
	The desirable features for quality science education in Tanzanian junior secondary schools	Responses in %		
		Agree	Not sure	Disagree
1	Presence of good educational policies			
2	Presence of sufficient teaching and learning resources			
3	Presence of good attributes among science teachers			
4	Presence of good collaboration among stakeholders			
5	Presence of active teacher development programmes in science			
6	Presence of good leadership attributes in education			
7	Presence of good and supportive learning environment			

Table 3: Limiting factors for quality SE

C/N	SITE			
	CASE			
	Strategies towards provision of quality SE in Tanzanian Junior secondary schools	Responses (%)		
		Agree	Not sure	Disagree
1	A need for policy review to address the current challenges in SE			
2	Improving learning support services and increasing the educational pathways			
3	Strengthening governance, management and accountability in educational sector.			
4	Improving the status of teachers and their teaching profession			
5	Strengthening the teacher development programs			
6	Redefining the science curricular focus			
7	Improving the collaboration among the educational stakeholders			
8	Building supportive learning environment.			
9	A need for pedagogical reforms in SE			
10	A need to develop a common understanding about quality SE			
11	A need for sharing the responsibility of providing quality SE			

Table 4: Strategies for overcoming the challenges towards quality SE

C/N	SITE			
	CASE			
	Factors limiting the provision of quality SE in Tanzanian junior secondary schools	Responses (%)		
		Agree	Not Sure	Disagree
1	Inadequate community support			
2	Lack of government support			
3	Lack of infrastructural facilities in schools			
4	Insufficient teaching and learning resources			
5	Ineffective strategy of decentralisation in education sector			
6	Ineffective integration of ICT in education			
7	Inadequate students' commitments, readiness and interests in learning			
8	Ineffective teacher attributes and their working conditions			
9	Ineffective policy of education			
10	Curricular irrelevance			
11	Poor command of English for both teachers and students			
12	Inadequate pedagogical approaches among teachers			
13	Irrelevance of science content in science text books			
14	Ineffective strategy towards provision of quality SE			
15	Poor assessment procedures in education			
16	Ineffective link between theory and practice of science

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APPENDIX J: The information sheet for students

Dear respondent!

My name is John Kalolo a PhD candidate at Victoria University of Wellington (New Zealand). I am currently doing the field work that is, collecting data about improving the quality of science education in Tanzanian ordinary level (O- level) secondary schools. The Study is in search of stakeholders' perspectives (including you) and what they consider as best practices for quality science education in Tanzanian O- level secondary schools. In this aspect the study simply explores the stakeholders' perspectives about quality science education in today's schools, its challenges and the agreed promising practices for future functional science education in schools. This is a chance for you to talk about and share your views on quality of science education in secondary schools today. The findings of this study are expected to outline useful guidelines which will not only help to benchmark what the students need to know, but also guide the scientific debates and reforms in Tanzanian science education system.

The research will involve policy makers, educators and school managers, and society including you as a part of the society to elicit your views on how best science education can be enacted in schools. You will participate in one focus group discussion of approximately one hour to one and half hours long involving you and your fellow students with the researcher. I kindly therefore invite you to participate in this activity.

Should you agree to be involved in this study, you will need to understand the following:

- a) The data will be collected together and analysed to produce a PhD thesis that will be available in the Victoria University of Wellington library. You will be sent a summary of the finding if you wish.

- b) Your identity and the name of the school in which you belong will remain confidential. All data collected from you will be coded to protect your identity and you should understand that you will always be kept unidentified in any written account of the research, and that all information used will remain non-identifiable.
- c) After and during focus group discussion you have a right to ask any questions or raise any concerns and provide comments about issues on the table. However should the discussion distress or upset you in any way contact me personally for further assistance.
- d) The researcher will tape-record your response as you provide your view about quality science education in o-level secondary schools, and how best it can be addressed in the context of Tanzania.
- e) The focus group discussion session will be flexible providing a chance for you to have breaks at your request and choose your comfortable location for that activity.
- f) Parts or all of your critiques and reflections on the subject matter might be included in the final report.
- g) The researcher might develop a report using your critiques and reflections to illustrate the best ways to enact science education in schools.
- h) You may withdraw your decision to participate in the study at any stage of data gathering without giving reasons and decide not to answer any particular questions about the study.
- i) If the researcher and you agree, the researcher might match some of your reflections with what other stakeholders are saying about best ways to enact science education in schools. You will be given a copy and will make the decision whether this can be shown to anyone else.
- j) You have a right to ask for an audio tape to be turned off at any time during focus group discussion.
- k) There are no risks to your participation in the focus group discussion for this study as the researcher is used to talking about this topic and,
- l) Also you should understand that the ethical clearance from Victoria University of Wellington Ethics Committee has been obtained for this study. Should you have any questions regarding the way the research is

conducted kindly contact Dr. Sue Cornforth, Chair of Ethics Committee, Victoria University of Wellington (sue.cornforth@vuw.ac.nz).

In case you have any questions or you wish to seek some clarifications about particular aspects in this study, kindly contact me or my academic supervisors at the email details in this table.

Researcher: Mr. John Fungulupembe Kalolo	Primary supervisor: Dr. Barrie Gordon. Email address : barrie.gordon@vuw.ac.nz
Email address: john.kalolo@vuw.ac.nz or mwakalolo@yahoo.ca	Second supervisor: Prof. Luanna Meyer Email address : luanna.meyer@vuw.ac.nz
Mobile phone: 00255713284459 (TZ) 00642108244763 (NZ)	Third supervisor: Dr. Azra Moeed Email address: azra.moeed@vuw.ac.nz

Please read the consent form thoroughly, sign it and return it to me. I will personally contact those who would have agreed to participate in the study so that we organize a convenient time for the discussion.

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APPENDIX K: The information sheet for interviewees

My name is John Kalolo a PhD candidate at Victoria University of Wellington (New Zealand). I am currently doing the field work that is, collecting data about improving the quality of science education in Tanzanian ordinary level secondary schools. The Study is in search of stakeholders' perspectives (including you) and what they consider as best practices for quality science education in Tanzanian secondary schools. In this aspect the study simply explores the stakeholders' perspectives about quality science education in today's schools, its challenges and the promising practices for future functional science education in schools. This is a chance for you to talk about and share your views on quality and relevance of science education in secondary schools today. The findings of this study are expected to outline useful guidelines which will not only help to benchmark what the students need to know, but also guide the scientific debates and reforms in Tanzanian science education system.

The research will involve educators and school managers, and society including you as an important respondent to elicit your views on how best science education can be enacted in schools. You will participate in one interview session of approximately be 60 to 80 minutes long involving you and your fellow students with the researcher. I kindly therefore invite you to participate in this activity. Should you agree to be involved in this study, you will need to understand the following:

- a) The data will be pooled together and analysed to produce a PhD thesis that will be available in the Victoria University of Wellington library. You will be sent a summary of the study if you wish.
- b) Your identity and the name of the department/ institution in which you belong will remain confidential. All data collected from you will be coded to protect your identity and you should understand that you will always be

kept unidentified in any written account of the research, and that all information used will remain non-identifiable.

- c) After and during interview you have a right to ask any questions or raise any concerns and provide comments about issues on the table. However should interview distress or upset you in any way contact me personally for further assistance.
- d) The researcher will tape-record your response as you provide your views about quality science education in secondary schools, and how best it can be addressed in the context of Tanzania.
- e) The interview session will be flexible providing a chance for you to have breaks at your request and choose your comfortable location for that activity.
- f) Parts or all of your critiques and reflections on the subject matter might be included in the final report.
- g) The researcher might develop a report using your critiques and reflections to illustrate the best ways to enact science education in Tanzanian secondary schools.
- h) You may withdraw your decision to participate in the study at any stage of data gathering without giving reasons and decline to answer any particular questions about the study.
- i) If the researcher and you agree, the researcher might match some of your reflections with what other stakeholders are saying about best ways to enact science education in schools. You will be given a copy and will make the decision whether this can be shown to anyone else.
- j) You have a right to ask for an audio tape to be turned off at any time during interview.
- k) There are no risks to your participation in the interview for this study as the researcher is used to talking about this topic and,
- l) Also you should understand that the ethical clearance from Victoria University of Wellington Ethics Committee has been obtained for this study. Should you have any questions regarding the way the research is conducted kindly contact Dr. Sue Cornforth, Chair of Ethics Committee, Victoria University of Wellington (sue.cornforth@vuw.ac.nz).

In case you have any questions or you wish to seek some clarifications about particular aspects in this study, kindly contact me or my academic supervisors at the email details in this table.

<p>Researcher: Mr. John Fungulupembe Kalolo</p> <p>Email address: john.kalolo@vuw.ac.nz or mwakalolo@yahoo.ca</p> <p>Mobile phone: 00255713284459 (TZ) 00642108244763 (NZ)</p>	<p>Principal supervisor: Dr. Barrie Gordon. Email address : barrie.gordon@vuw.ac.nz</p> <p>Second supervisor: Prof. Luanna Meyer Email address : luanna.meyer@vuw.ac.nz</p> <p>Third supervisor: Dr. Azra Moeed Email address: azra.moeed@vuw.ac.nz</p>
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Please read the consent form thoroughly, sign it and return it to me. I will personally contact those who would have agreed to participate in the study so that we organize a convenient time for the discussion.

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APPENDIX L: The information sheet for Teachers

Dear respondent!

My name is John Kalolo a PhD candidate at Victoria University of Wellington (New Zealand). I am currently doing the field work that is, collecting data about improving the quality and relevance of science education in Tanzanian ordinary level secondary schools. The Study is in search of stakeholders' perspectives (including you) and what they consider as best practices for quality science education in Tanzanian schools. In this aspect the study simply explores the stakeholders' perspectives about the quality of science education in today's schools, its challenges and the promising practices for future meaningful science education in Tanzanian secondary schools. This is a chance for you to share your views on quality and relevance of science education in secondary schools today. The findings of this study are expected to outline useful guidelines which will not only help to benchmark what the students need to know, but also guide the scientific reforms, debates and practices in Tanzanian science education.

The research will involve policy makers, school managers, and society including you as a part of educators to elicit your views on how best science education can be enacted in schools. You will participate in filling in questionnaires which will approximately be 60 to 80 minutes long involving you and your fellow teachers. I kindly therefore invite you to participate in this activity.

Should you agree to be involved in this study, you will need to understand the following:

- a) The data will be pooled together and analysed to produce a PhD thesis that will be available in the Victoria University of Wellington library. You will be sent a summary of the study if you wish.

- b) Your identity and the name of the school in which you belong will remain confidential. All the data collected from you will be coded to protect your identity and you should understand that you will always be kept unidentified in any written account of the research, and that all information used will remain non-identifiable.
- c) After and during interview you have a right to ask any questions or raise any concerns and provide comments about issues on the table. However should the discussion distress or upset you in any way contact me personally for further assistance.
- d) You may also be asked to participate in a variety of verbal conversation between you, the researcher and your fellow science teachers in a focus group discussion which might last for 1 hour long at your convenient time on tasks that will be identified by the researcher
- e) The researcher will transcribe your reflections on the subject matter as you will have written your views about quality and relevant science education in secondary schools, and how best it can be addressed in the context of Tanzania.
- f) The session of filling in questionnaire will be flexible providing a chance for you to have breaks at your request and choose your comfortable location for that activity.
- g) Parts or all of your critiques and reflections on the subject matter might be included in the final report.
- h) The researcher might develop a report using your critiques and reflections to illustrate the best ways to enact science education in Tanzanian secondary schools.
- i) All notes, copies of questionnaire and raw data will be stored securely kept in a locked cabinet in the researcher's office and you have a right to ask for them to be destroyed after completion of the study.
- j) You may withdraw your decision to participate at any stage of data gathering without giving reasons and decline to answer any particular questions about the study.
- k) The researcher will check with you at any time to confirm on whether what you will have written is what you meant to say after data collection. You will have the right to alter or delete any information to the transcription or notes collected from you.

- l) There are no risks to your participation in filling the questionnaire for this study as the researcher is used to talking about this topic.
- m) If the researcher and you agree, the researcher might match some of your reflections with what other stakeholders are saying about best ways to enact science education in schools. You will be given a copy and will make the decision whether this can be shown to anyone else.
- n) The researcher will use the information solely for the purpose of this research, conference presentations and other publications in the refereed journals and,
- o) Also you should understand that the ethical clearance from Victoria University of Wellington Ethics Committee has been obtained for this study. Should you have any questions regarding the way the research is conducted kindly contact Dr. Sue Cornforth, Chair of Ethics Committee, Victoria University of Wellington (sue.cornforth@vuw.ac.nz).

In case you have any questions or you wish to seek some clarifications about particular aspects in this study, kindly contact me or my academic supervisors at the email details in this table.

<p>Researcher: Mr. John Fungulupembe Kalolo</p> <p>Email address: john.kalolo@vuw.ac.nz or mwakalolo@yahoo.ca</p> <p>Mobile phone: 00255713284459 (TZ) 00642108244763 (NZ)</p>	<p>Principal supervisor: Dr. Barrie Gordon. Email address : barrie.gordon@vuw.ac.nz</p> <p>Second supervisor: Prof. Luanna Meyer Email address : luanna.meyer@vuw.ac.nz</p> <p>Third supervisor Dr. Azra Moeed Email address: azra.moeed@vuw.ac.nz</p>
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Please read the consent form thoroughly, sign it and return it to me. I will personally contact those who would have agreed to participate in the study so that we organize a convenient time for filling in the questionnaires.

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APPENDIX M: Consent Form for Interviewees

The study you are about to participate is part of the series of studies on improving the quality of science education in secondary schools. The study explores your perspectives towards quality science education and promising practices for quality science education in Tanzanian ordinary level secondary schools. By putting a tick sign (✓) against each of the declarations here stated and signing this form you provide your consent to participate in the study and you are confident on the following:

- a) You have read and understood the information sheet provided and you had enough opportunity to ask questions about the study and that all inquiries concerning your involvement in the study have been answered to your satisfaction. ☐
- b) You know the benefits and risks of your involvement in this study. So taking part in this study is your own choice that you can decide to leave at any time without giving reasons and without penalty. ☐
- c) Your identity will remain confidential in any written account of the research, and that all information used will remain non-identifiable. In case of any problem you know who contact. ☐
- d) The researcher will tape record the interview and all notes, audio tapes and raw data will be stored securely in a locked cabinet and password protected computers accessible by the researcher only and you have a right to ask for them to be destroyed after completion of the study. ☐
- e) The researcher will check with you at any time to confirm on whether what he recorded is what you meant to say during or/and after data collection. At this stage you will have the right to alter or delete any information to the transcription or notes collected from you. ☐
- f) The researcher might match some of your reflections with what other stakeholders are saying about best ways to enact science education in

schools. But before that you will be given a copy to decide whether this can be shown to anyone else. You have a right to ask for a summary of the study findings when you wish through your address provided. ☐

g) The final thesis of this study will be kept at the Victoria University of Wellington library and may solely be used for conference presentations and article publications in the referred journals. ☐

h) You will need a summary of the study findings via your address provided ☐

Should you decide to either participate in this study or not, please sign the corresponding part that suits your interest and return this form to John F Kalolo (the researcher).

I agree to take part in this study at this time under the conditions set out in the information sheet and in this form.	I decline to take part in this study at this time under the conditions set out in the information sheet and in this form.
Signed..... Name..... Date..... Email address or other contacts	Signed..... Name..... Date..... Email address or other contacts

Thank you for your help
John Fungulupembe Kalolo

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APPENDIX N: Consent form for Teachers

The study you are about to participate is part of the series of studies on improving the quality of science education in secondary schools. The study explores your perspectives towards quality science education and promising practices for quality science education in Tanzanian ordinary level secondary schools. By putting a tick sign (✓) against each of the declarations here stated and signing this form you provide your consent to participate in the study and you are confident on the following:

- a) You have read and understood the information sheet provided and you had enough opportunity to ask questions about the study and that all inquiries concerning your involvement in the study have been answered to your satisfaction. ☐
- b) You know the benefits and risks of your involvement in this study. So taking part in this study is your own choice that you can decide to leave at any time without giving reasons and without penalty. ☐
- c) Your identity will remain confidential in any written account of the research, and that all information used will remain non-identifiable. In case of any problem you know who contact. ☐
- d) The researcher will tape record the discussion and all notes, audio tapes and raw data will be stored securely in a locked cabinet and password protected computers and you have a right to ask for them to be destroyed after completion of the study. ☐
- e) The researcher will check with you at any time to confirm on whether what he recorded is what you meant to say during or/and after data collection. At this stage you will have the right to alter or delete any information to the transcription or notes collected from you. ☐
- f) The researcher might match some of your reflections with what other stakeholders are saying about best ways to enact science education in

schools. But before that you will be given a copy to decide whether this can be shown to anyone else. You have a right to ask for a summary of the study findings when you wish through your address provided. ☐

g) The final thesis of this study will be kept at the Victoria University of Wellington library and may solely be used for conference presentations and article publications in the referred journals. ☐

h) You will need a summary of the study findings via your address provided ☐

Should you decide to either participate in this study or not, please sign the corresponding part that suits your interest and return this form to John F. Kalolo (the researcher).

I agree to take part in this study at this time under the conditions set out in the information sheet and in this form.	I decline to take part in this study at this time under the conditions set out in the information sheet and in this form.
Signed.....	Signed.....
Name.....	
Date.....	Name.....
....	...
Email address or other contacts	Date.....
.....	
	Email address or other
	contacts
	
	..

Thank you for your help
John Fungulupembe Kalolo

Faculty of Education
School of Education

APPENDIX O: Consent form for students

The study you are about to participate is part of the series of studies on improving the quality of science education in ordinary level secondary schools. The study explores your perspectives towards quality science education and promising practices for quality science education in Tanzanian secondary schools. By putting a tick sign (✓) against each of the declarations here stated and signing this form you provide your agreement to participate in the study and you are confident on the following:

- a) You have read and understood the information sheet provided and you had enough opportunity to ask questions about the study and that all inquiries concerning your involvement in the study have been answered to your satisfaction. ☐
- b) You know the benefits and risks of your involvement in this study. So taking part in this study is your own choice that you can decide to leave at any time without giving reasons and without penalty. ☐
- c) Your identity will remain confidential in any written account of the research, and that all information used will remain non-identifiable. In case of any problem you know who contact. ☐
- d) The researcher will tape record the interview and all notes, audio tapes and raw data will be stored securely in a locked cabinet and password protected computers and you have a right to ask for them to be destroyed after completion of the study. ☐
- e) The researcher will check with you at any time to confirm on whether what he recorded is what you meant to say during or/and after data collection. At this stage you will have the right to alter or delete any information to the transcription or notes collected from you. ☐
- f) The researcher might match some of your reflections with what other stakeholders are saying about best ways to enact science education in

schools. But before that you will be given a copy to decide whether this can be shown to anyone else. You have a right to ask for a summary of the study findings when you wish through your address provided. ☐

g) The final thesis of this study will be kept at the Victoria University of Wellington library and may solely be used for conference presentations and article publications in the referred journal ☐

h) You will need a summary of the study findings via your address provided ☐

Should you decide to either participate in this study or not, please sign the corresponding part that suits your interest and return this form to John F Kalolo (the researcher).

I agree to take part in this study at this time under the conditions set out in the information sheet and in this form.	I decline to take part in this study at this time under the conditions set out in the information sheet and in this form.
Signed..... Name..... Date..... Email address or other contacts	Signed..... Name..... . Date..... . Email address or other contacts

Thank you for your help
John Fungulupembe Kalolo

APPENDIX P: Research permit from site A

The United Republic of Tanzania

Prime Ministers' Office

REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

ILALA DISTRICT

Phone Address:

Phone No: 2203185/2203182

In reply quote:

Ref. No: AB. 65/206/02/97

DISTRICT COMMISSIONER'S OFFICE

ILALA DISTRICT

P. O. Box 15486,

DAR ES SALAAM

11st September, 2012

Municipal Director,
P. O. Box 20950,
ILALA – D'SALAAM.

RE: RESEARCH PERMIT

Mr. John F. Kololo is a researcher from Victoria University of Wellington Newzealand, who has been permitted to undertake a field work research on "**Quality of Science Education in Tanzanian Junior Level Secondary Schools:**" in Dar es Salaam. Case study Ilala District from August , 2012 to February, 2013.

Therefore, you are asked to give the said researchers necessary assistances and Cooperation.

A handwritten signature in blue ink, appearing to read 'J. J. Ngonyani'.

J. J. Ngonyani

District Administrative Secretary

ILALA
DISTRICT ADMINISTRATIVE
SECRETARY
ILALA

Copy: Mr. John F. Kololo,
Victoria University of Wellington Newzealand

Principal/Vice Chancellor,
Victoria University of Wellington Newzealand

APPENDIX Q: Research permit for site B

**THE UNITED REPUBLIC OF TANZANIA
PRIME MINISTER'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT**

IRINGA REGION:

**Regional Commissioner's Office,
P.O. Box 858,
IRINGA.**

Tele: 2702021/2702715
Fax: 2702082
For Reply please quote:

Ref. No. FA.265/255/01/VOL.B/210

28th September, 2012

Municipal Director,
P.O. Box 162,
IRINGA

District Executive Director,
P.O. Box 108,
IRINGA

**RE: A PERMIT FOR JOHN F.KALOLO A BONAFAIDE STUDENT OF THE
UNIVERSITY OF DAR-ES-SALAAM TO CONDUCT AN EDUCATIONAL
RESEARCH IN YOUR COUNCIL.**

With reference to the above heading.

I hereby inform you that one **John F.Kalolo** who is a bonafide student of The University of Dar-Es-Salaam has been granted a permit by The Iringa Regional Administrative Secretary to carry out an educational research in your Councils about **The quality of Science Education in Tanzanian 'O' Level Secondary Schools basing on the perspectives of stakeholders.**

We therefore, kindly implore you and your supporting staff to be forthcoming to him by availing the same any needful support which is within your reach in order to help him realize accordingly the cherished objectives of this study.

Please accept my profound appreciation of your co-operation in this endeavour in advance. Also I wish you all the best for the season.

Yours sincerely,

Mwl. Euzebio B. Mtavangu

**For REGIONAL ADMINISTRATIVE SECRETARY
IRINGA**

Copy : Vice Chancellor,
University of Dar-Es-Salaam,
P.O. Box 35091,
DAR-ES-SALAAM

**FOR REGIONAL ADMINISTRATIVE SECRETARY
IRINGA**

APPENDIX R: Research permit from the Tanzanian Ministry of Education and vocational training

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION AND VOCATIONAL TRAINING

Cable: "ELIMU" DAR ES SALAAM
Telex: 41742 Elimu Tz.
Telephone: 2121287, 2110146
Fax: 2127763

Post Office Box 9121
DAR ES SALAAM

In reply please quote:

Ref. ED/EP/ERC/VOL V/ 124

Date: Thursday, September 20, 2012

The Regional Administrative Secretary-Iringa Region.

Attn: (Regional Education Officer)

RE: RESEARCH CLEARANCE FOR MR. JOHN FUNGULUPEMBE KALOLO

The mentioned is bonafide PhD student of the Victoria University of Wellington who is conducting research titled "**Quality of Science Education in Tanzanian Ordinary Level (Junior) Secondary Schools: A case Study on Stakeholders' Perspectives, Issues and Promising Practices**" as part of his course programme for the award of PhD.

The researcher needs to collect data and necessary information related to the research at Council level and sampled Secondary schools.

In line with the above information you are being requested to provide the needed assistance that will enable him to complete this study successfully.

The period by which this permission has been granted is from **September 20, 2012 to February 28, 2013.**

By Copy of This Letter, **Mr. John Fungulupembe Kalolo** is required to submit a copy of the report (or part of it) to the *Permanent Secretary, Ministry of Education and Vocational Training* for documentation and reference.

Yours truly,

Abdallah S. Ngodu
For Permanent Secretary

✓ CC: Mr. John Fungulupembe Kalolo,
Victoria University of Wellington,
P.O.Box 17-310 Wellington 6012 New Zealand.

Appendix S: Ethics Research Approval letter from Victoria University of
wellington

FACULTY OF EDUCATION TO Box 17-310 Wellington 6142, New Zealand
Website: www.victoria.ac.nz

15 April 2012

John Kalolo
PhD Student
Victoria University of Wellington Faculty of Education
C/- School of Educational Policy and Implementation
Donald Street
Wellington

Dear John

RE: Ethics application SEPI/2012/13 RM 19301

I am pleased to advise you that your ethics application '**Quality of science Education in Tanzanian Ordinary Level (Junior) Secondary Schools: A Case Study on Stakeholders' Perspectives, Issues and Promising Practices.**', with the required changes, has been approved by the Victoria University of Wellington Faculty of Education Ethics Committee. Please note that the approval for your research to commence is from the date of this letter.

Best wishes for your research.

Yours Sincerely

A handwritten signature in blue ink, reading 'J. A. Loveridge'.

Dr Judith Loveridge

Co-Convener
Victoria University of Wellington Faculty of Education Ethics Committee