INVESTIGATING EFFECTS OF CONTEXTUALIZED SCIENCE CURRICULAR EXPERIENCES ON STUDENTS' LEARNING AND THEIR TEACHERS' TEACHING IN TANZANIA

by

Winston Edward Massam

B.Sc. (with Education), University of Dar es Salaam, 2002

M. Ed. (Science) University of Dar es Salaam, 2006

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Curriculum Studies)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

March 2019

The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, the dissertation entitled:

Investigating effects of contextualized science curricular experiences on students' learning and their teachers' teaching in Tanzania

submitted by Winston Edward Massam in partial fulfillment of the requirements

the degree of Doctor of Philosophy

in Curriculum Studies

Examining Committee:

Dr. Samson Nashon

Supervisor

Dr. David Anderson

Supervisory Committee Member

Dr. Sandra Scott

Supervisory Committee Member

Dr. Marlene Asselin

University Examiner

Dr. Stephen Petrina

University Examiner

Abstract

This study investigated the effects of contextualized science curricular experiences on students' learning and their teachers' teaching in a Tanzanian context. One hundred and eighty (180) students from a select secondary school participated in an 8-months science curriculum with at least one contextualized science lesson occurring once a week. Data was collected from May to December 2013 through mixed methods techniques. Descriptive statistics, principal component, and confirmatory factor analyses constituted the quantitative analytical methods. These were complemented by qualitative methods including thematic analysis, outcomes of which characterized the students' and teachers' experiences of contextualized science.

Key findings revealed: i) The approach helped students to learn science in a more meaningful way compared to the traditional approach which promoted learning by memorization of facts and preparation for exams; ii) The approach helped students deepen their conceptual understanding including applications in various real-world settings; iii) Students considered the benefits of learning science in this way as being over and above the quest to finish the syllabus and pass exams; iv) Students' experiences with contextualized science learning had implications on how their teachers interpreted and enacted the curriculum; and v) The approach stimulated collaborative learning and teaching among students, their teachers, and between the students and their teachers. The study's findings also revealed three major reasons for teachers' reluctance to use contextually based mediations in their every day science teaching. These included: i) The centralized, overloaded, and yet, rigid and strict nature of Tanzania's syllabi; ii) Prior teacher preparation and schooling background; and iii) Dominant traditional paper and pencil mode of assessment and evaluation of students. The study's findings have implications for curriculum and instruction as well as theory and future research.

Lay Summary

The purpose of this study was to investigate how incorporating activities from learners' everyday life environment, such as those done by *Wajasiriamali* (a group of local entrepreneurs in Tanzania who engage in small scale manufacturing and processing of consumer goods), would influence students' learning, and in turn, their teachers' teaching. Findings of the study contribute to the understanding of the role real world learning experiences can play in enhancing meaningful learning, particularly meaningful learning of school science, as well as the potential this kind of learning has in influencing teachers' ways of teaching. A recent study conducted in Kenya in 2008 - 2013 (Anderson, et al., 2015; Nashon & Anderson, 2008, 2010, 2013a, 2013b), generated encouraging insights which inspired the current study. This study's findings make a significant contribution to the growing body of knowledge in science education and education within and across disciplines.

Preface

This dissertation is original, unpublished and independent work by the author, W. E. Massam. The study obtained the approval of the UBC Research Ethics Board (Behavioural Research Ethics Board; UBC BREB Number: H12-03387), and that of the University staff and students research clearance from the Vice Chancellor of the University of Dar es Salaam, Tanzania, with ref. no. AB3/12(B).

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Acknowledgements

I would like to express my sincere gratitude to my advisor Professor Samson Nashon for the continuous support of my PhD study and related research, for his patience, motivation, and immense knowledge. His unending guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisor and mentor for my PhD study.

Besides my advisor, I would like to thank the rest of my thesis committee: Professor David Anderson and Dr. Sandra Scott, for their insightful comments and encouragement, but also for the hard questions, which incentivized me to widen my research from various perspectives.

Special gratitude goes to the University of British Columbia for the financial support I received through the Faculty of Education Graduate Awards and International Partial Tuition Scholarships. I would also like to thank Drs. Samson Nashon and David Anderson for employing me as a research Assistant. The Dar es Salaam University College of Education provided funding for my research work. To this, I am very much thankful.

I thank my fellow PhD cohort mates for the stimulating and thoughtful discussions and encouragements, and of course, all the fun we have had during the period of my study. You were such good friends and family during my time at UBC.

Last but not the least; I would like to thank my family: my parents, my brothers and sisters, my wife and my beloved daughter for supporting me spiritually throughout my thesis writing and the whole PhD life away from them.

Dedication

This thesis is dedicated to my parents Edward Massam and Janeth Kiwelu,

my wife Sia Mosha, and my beloved daughter Beatrice Massam.

Without you, none of my success would be possible.

May God continue to shower to you unending blessings

Chapter 1: Introduction

This study reports an investigation of the effect of contextualized science curricular experiences on students' learning and their teachers' teaching in a Tanzanian context. Drawing on their views/perceptions, the study aimed to explore how science lessons that integrate both classroom and out-of-classroom real life learning activities impact on students' learning, which in turn, affect their teachers' practices of high school science teaching. Central to this study was the idea of contextualizing science curriculum and instruction where the mandated science curriculum was interpreted and enacted in ways that linked school science with the learners' real world, and in this case, with *Wajasiriamali*[1] manufacturing and processing activities, which are believed to be rich in scientific phenomena, from which students can investigate and learn (c.f. Nashon & Anderson, 2013).

The intention of contextualizing science curriculum, what other scholars have termed as teaching science in context or context-based science learning, has been stated in the literature as creating relevance in science, as well as increasing learners' interest and motivation to learn science (Del Rosario, 2009; Lindahl, 2003; Lubben & Bennett, 2008; Lyons, 2003). Yet, King and Ritchie (2012) observe that any attempt to link classroom science with the learners' real world is limited if there is no clear understanding of their experiences of learning science in

[1] '*Wajasiriamali'* is a Swahili translation for 'local entrepreneurs'. This is a popular name given to a group of artisans (men and women) who engage in small scale manufacturing and processing of such products as fabricated metal buckets and boxes, kerosene lamps, cooking pots and utensils, charcoal stoves, chicken brooders etc; small scale manufacturing of chemical related products such as loundry and detergent soaps, air freshener, stain remover, ink manufacture, chalk making, lather dyeing, dyeing of clothes etc; and small scale food processing and packaging (mostly done by women groups) such as processing of wine/juice from fruits, and processing and packaging of such products as jam, butter, mango pickle, soya drink, ground nuts, honey, cooking oil, spices etc.They are known and reorganized by the people of all age and cadre for their great service to the people of middle and lower class. Some of the formal organized groups are sponsored by the Tanzania government in collaboration with ILO (ILO, 2008).

culturally relevant real world context. Zimmerman (2012), on the other hand, states that, since learning involves thinking, and that thinking has intertwined cognitive, social, and contextual factors, the analysis of learning must consider the context, the artifacts, and the people with whom learners interact during the course of learning.

Based on this understanding, learning is viewed as transforming learners' views or perceptions, which develop continuously within and across a multiplicity of socially situated settings (Nashon & Anderson, 2013, citing Driver, 1983; Mintzes et al., 1997, 1998). In addition, this view centres around the idea that learners' views or perceptions rarely develop instantaneously but rather through catalytic events that connect classroom science to real world experiences which have the potential to gradually affect their views or perceptions towards learning over a period of time (Anderson, Lucas, Ginns, & Dierking, 2000; Nashon & Anderson, 2013).

Given the nature of this study, I therefore, grounded my research in sociocultural and contextual learning perspectives which envision knowledge to reside within and across the social and physical context in which it is used (Cole, 1991; Hickey, 2003; Kozulin, 2003; Rogoff, 1990, 2008; Vygotsky, 1978). Building upon this, I endeavored to learn what views would students and teachers hold of school science learning experiences which integrate both classroom and out-of-classroom real-life learning activities drawn from students' social and culturally relevant contexts, as they progress through an eight-month contextualized science learning study.

1.1 Background and rationale for the study

Most sub-Saharan African countries and Tanzania in particular, adopted systems and structures of education from their formal colonial governments. Their curricula, text and reference books, teaching and learning materials and resources, as well as pedagogical practices were inherited from former colonial education systems with few modifications. In the literature, the text and reference books, particularly those of science subjects, have been criticized for the tendency to be decontextualized as they present discourses, contexts, and examples learners are not able to follow, or, they discuss a world that is artificial rather than natural to the learners (Campbell & Lubben, 2000; Hamilton et al., 2010; Odhiambo, 1981; O-saki et al., 2002). Science text and reference books do not include learners' lived experiences from which the science that they learn in school is actually drawn (c.f. Lawton, Berns & Sandler, 2009; Driver, et al., 1994; Knamiller, et al., 1995; Lyons, 2006; Osborne & Collins, 2001; Tytler & Osborne, 2012).

Given this, the challenge and struggle to develop science education in sub-Saharan African countries has been in twofold. First, the struggle between the development of meaningful science related to students' personal experiences and local or social contexts, as opposed to decontextualized science has tended to impose learning contexts and experiences outside the learners' experiences (Eyenaka, Ekanem, & Uwak, 2013; Knamiller, 1984; Lubben & Bennett, 2008; O-saki et al, 2002; Yishak & Gumbo, 2015). Despite attempts to develop and incorporate relevant science teaching and learning materials such as African Primary Science Program (APSP), School Science Project in East Africa (SSP), and School Mathematics Project (SMP), Zimbabwe Science (ZIMSCI), most of these projects were not successful (Chisholm & Leyendecker, 2008; O-saki et al., 2002) due to the failure to define appropriate contexts, that is, whether materials should focus on indigenous rural experiences, urban or sub-urban culture, or multinational cultures (O-saki et al., 2004; Yishak & Gumbo, 2015). Research indicates that the question of 'relevance' is a complex issue especially for Africa because: relevance may not be applicable at all times (Jegede, 1996; Schweisfurth, 2011); depends on where you are (Ogunniyi, 1988; Tabulawa, 2013); and also which environment the learners are familiar with (Brodie, et al., 2002; Driver et al., 1985; Tabulawa, 2013; Taylor, 2017). Results of the failure of science teaching and learning materials developed for African contexts was then, the resumption into externally imported text and reference books which have dominated the education systems in most of these countries, Tanzania included.

Now that most of the science text and reference books that dominate the system have been externally imported, and characterized as beset with Western perspectives and contexts, another challenge to improve science education has been how, through these same text and reference books, science ideas and concepts could be taught in ways that relate to learners' everyday experiences to raise their motivation and interest to actively engage in science learning and also enable learners to see the meaning of science in their everyday lives. It is argued that school science cannot be reduced to imparting knowledge and facts copied from traditional science textbooks to students, through the conventional transmission methods that do not take into account learners' needs, interest, and contexts, from which their rich prior knowledge and experiences are drawn (Osborne & Collins, 2001; Driver, 1989; Lyons, 2003; Koul, 1997). On the contrary, school science ought to be directed towards facilitating learners to examine, test, and confirm or modify ideas about phenomena in the world around them and make use of this knowledge and experience to shape practical actions as well as solve real world problems within their environment (Campbell & Lubben, 2000; Koul, 1997; Osborne & Collins, 2001; Tytler & Osborne, 2012).

1.1.1 Statement of the problem

Immediately following attainment of independent from the UK in 1961, Tanzania adopted a socialist type of political system with emphasis on self-reliance and collectivism (Ujamaa) (Nyerere, 1967, 1968). This saw the proliferation of *Wajasiriamali* enterprise, which has recently taken the lead in the Tanzania's local economy. Yet, despite the emphasis on implementation of self-reliance doctrine as well as the prevalence of *Wajasiriamali* enterprises, ironically, there was no attempt to link school science and the locally evolving industries (Mosha, 1990).

Recent research in teaching and learning of science in Tanzania has shown that, with the curriculum borrowed from the colonial education system, school science has been organized, structured, and taught in a decontextualized manner that leaves students and the society at large to continue perceiving science as a foreign subject with little or no value to students' lives beyond the classroom (Hamilton et al., 2010; Kalolo, 2014; Osaki, 2007; Rugumamu, 2011; Semali & Mehta, 2012). According to Semali and Mehta (2012), despite the current curriculum reform efforts "planners have continued to struggle with the colonial legacies, and the tension has been evident in the highly structured and prescriptive physics, chemistry, and biology syllabi…[prepared by] the Tanzania Institute of Education" (p. 228). At the same time, Hamilton et al. (2010) observe that neither the science curricula nor the current instructional practices have placed sufficient emphasis on the use of context- and inquiry-based teaching and learning of science. Science learning has been beset with memorization of concepts, and the effort has been to reproduce these concepts during exams; however, many students fail to do so (Kalolo, 2014; O-saki, 2004; Rugumamu, 2011). Despite a number of teacher professional development programs put in place to support relevant, meaningful, and engaging science learning, the tendency has been a relapse to the old traditional teacher-centered pedagogies. According to studies (Kalolo, 2014; Kitta & Tilya, 2018; Vavrus & Bartlett, 2013), the most commonly mentioned reason is the fact that most of the professional development programs have been imposed one-shot training, that do not take into account the context of the teachers and students. According to Hamilton et al. (2010) teachers have continued to use teacher-centered pedagogies that do not provide students with the opportunity to make important connections between science ideas and concepts they learn in school and the application and value to their lives after school (c.f. Semali & Mehta, 2012; Voogt et al., 2009).

With the highly examination-driven education system in Tanzania, classrooms have become centres for passive consumption of knowledge to be reproduced during final exams (Kalolo, 2014; Kitta & Tilya, 2018). Yet, studies have identified a range of benefits associated with contextualized/context-based science instruction and learning. The use of learners' everyday experiences has been portrayed not only as adding to the meaningful learning of the school science but also enabling learners to take control of their own learning, increase their appreciation of place of science within their world, and also, deepening their science conceptual understanding (Rayner, 2005). Peacock (1995) observes that contextualized science learning increases motivation, enjoyment, and access to the knowledge of science. Moreover, Campbell and Lubben (2000) note that the context-based instruction has the potential to encourage the development of skills, attitudes, and routines relevant to the work places and encourage reasoning and decision making skills including those related to the development of science and technology within the society.

Though multiple models are discussed in the literature for contextualizing science (e.g. Anderson, et al., 2015; Hull, 1995; Johnson, 2002; Karweit, 1993; Nashon & Anderson, 2008, 2010, 2011), there has been no research conducted in Tanzania on this topic. Hence, this study addressed the following research question:

What is the effect of contextualized science curricular experiences on students' learning, which in turn, affects their teachers' teaching in the Tanzanian context?

1.1.2 Purpose and sub-research questions for the study

The purpose of this study was therefore to investigate the effect of contextualized science curricular experiences on students' learning and their teachers' teaching in a Tanzanian context. More specifically, the study intended to observe, analyze, and interpret students' and teachers' views or perceptions of their experiences with this approach to science learning, having participated in an eight months contextualized science instruction and learning project. Thus, to achieve this, the study's main research question was guided by the following sub-questions:

1. How do high school students experience science learning in a science unit that integrates both classroom and out-of-classroom real life science learning activities?
2. How does students' success in this way of science learning in Tanzania affect their teachers' teaching?
3. What factors in the current high school teaching and learning in Tanzania prevent teachers from employing and utilizing contextually based mediations in the teaching and learning of the school science, and how these could better be addressed?

1.1.3 Significance of the study

It was anticipated in the present study that knowing the effect of contextualized science curricular experiences on students' learning and their teachers' teaching would be of vital importance in the development of relevant and meaningful science learning experiences, given that the new/current curriculum in Tanzania emphasizes meaningful science learning that results in the development of student competencies in various skills (the competence-based curriculum). Moreover, policy makers and curriculum developers, could use this study's findings to inform curriculum reform processes, including the development of capacity building programs that improve the use of context-based instructional practices for the successful implementation of the current competence-based curiculum (Kitta & Tilya, 2018).

As Semali and Mehta (2012) observe, the divergence between implementation of STEM education in Tanzania has left many students after 4-6 years of secondary education engaged with trades such as street vending, which are short term subsistance activities, rather than engagement with the long term pursuits that would lead to the growth of intrepreneurship activities necessary for the anticipated revolutionalized industrial sector. Examining students' and teachers' views of the science learning experiences that integret the school science with activities found in learners' everyday environment, such as *Wajasiriamali* manufacturing and processing activities, would be a key step towards revolutionalization of the popular *Wajasiriamali* sector, for the future advancement of the industrial sector in Tanzania.

A few research has been conducted in this area in sub-Saharan African countries, and Tanzanian in particular, to examine the impact that the contextualized science curricular experiences can have on students' learning as well as teachers' teaching. While a similar study in Kenya (Anderson, et al., 2015; Nashon & Anderson, 2008, 2010, 2011) generated encouraging insights into this approach to science learning, findings of the present study could make significant contribution to this growing body of knowledge.

1.2 Researcher positionality

> *"Memory work provides that "snapshot" of lived curriculum, one that enables us to use our classroom [schooling] stories as a basis of our research" (Weenie, 2008, p. 546, citing Jones, 1991)*

My passion to research in classroom teaching and learning evolved within the realms of my lived experiences as a student and a teacher, in a Tanzanian context. I will share my schooling story to demonstrate my connection to my research pursuit.

As a primary school student, I went through a system of education, which I have always equated with an 'authoritarian or dictatorship system', where a student had little or no room to question, argue, apologize, or even defend him/herself in case they made a mistake. A system where students were 'hunted' for the mistakes they made, and rated based on the 'bad things' they committed rather than the 'good things' they attempted or contributed. A system where caning and other corporal punishments were the order of the day. Hiding 'for your safety' as you saw the teacher coming your way was a daily event. While given much respect by the society, unlike in the recent time, teachers were seen as the knower and giver of everything, and students as merely recipients. In class, teachers owned knowledge and would dictate what we were to learn, understand, and write in our exercise books. If you did anything outside of these rules, you were always in trouble for it. I remember, every Friday, all our exercise books would be collected, not for the purpose of marking classroom assignments or activities but, for checking whether we properly copied teachers' notes from chalkboards, and our work was free from ‘unnecessary’ summaries which they considered *rubbish*! When returning the exercise books, a good student would be awarded/applauded for his/her neatness at writing/copying the notes and rarely praised for understanding the subject matter. The latter would come later, we were told! A good student was one who would be an expert in transferring lesson notes from the exercise books to the examination booklets. And when returning results, teachers would give commending comments like, “Ooh…s/he is very good at transferring…s/he did just like it was in my lesson notes”, or sometimes such comments as “s/he reproduced just like my marking scheme”. These, and similar comments praised students who were good at memorizing and transferring/ reproducing the lesson notes in exams. And these comments were cherished and celebrated by students.

There was no significant difference between elementary and high school. With small differences, the same situation as described above existed in high school, and in fact, the focus on learning by memorization was worse. Copying notes from teachers’ notes books was the main activity. These notes were produced directly from ‘Western’ books of Physics, Chemistry, Biology, Agriculture, and Geography with little or no examples, illustrations, or reflections on and/or from our own everyday life experiences that we lived in, or, that we were part of!

Yet, Tanzania is a land with so many beautiful characteristic features and ongoing activities from which we could learn about geography and agriculture. Tanzania has big mountains, beautiful lakes, natural beaches, and natural forests as well as large tracts of fertile arable land and plantations across the region, with a variety of both food and cash crop production activities. Yet, in school much of the emphasis was put in to such topics as Maize production in the United States (US), fruit production in the Middle East, and timber production in Amazon forest. Tanzania has local factories and small scale industries which use locally available materials to produce finished goods including soap making, cloth making, and iron works. These were ideal spaces for inspiring or motivating students to learn chemistry, biology, physics, and mathematics. There is also a small scale manufacturing/production sector, popularly known as *Wajasiriamali*, which has recently began to grow to accommodate a large portion of youth who for various reasons could not continue to tertiary level education. Again, activities in this sector are said to be rich in scientific phenomena which students could investigate and learn from in a variety of ways. However, our school learning was, and has not been made to reflect on/ or link to these important sectors and contexts. This is not to say we did not learn from Western books or Western knowledge.

As I reflect on this schooling background, my concern has always been about relevance. Is it not necessary for learners to learn the knowledge they find useful in their everyday lives? Or, can there not be ways to bring 'Western' knowledge to the immediate access and experiences of the learners, in their local context, so they find it relevant, meaningful and useful? Can there not be ways to link Western knowledge and the local contextual knowledge so much so that the knowledge given to our learners is culturally and contextually relevant, so that it helps them to advance science and technology from what they have? What about ways of knowing and managing learning? What are the best ways to engage with learning, in our context? Can there be ways in which to balance between the teacher-centered learning and the recently promoted learner-centered constructivist learning, to make school learning friendly, appealing, interesting, exciting, and enjoyable to the learners? Rather than the boring, uncaring, and threatening environment that has dominated many of our classrooms for decades? These and many other questions have always caught my thoughts as I take the back seat and reflect on my own self as a teacher and an instructor in the current time.

Being an experienced teacher, and a growing researcher in classroom learning, I believe, there is no reason why learners should not enjoy learning, and moreover, they should be learning something they find relevant and beneficial to their immediate lives. In Tanzania, most of the junior high school graduates who do not have the opportunity to attend senior high school or other tertiary level institutions, are often characterized as desperate loiterers in cities and town streets with no jobs or hope (Banks, 2016; Hamilton, 2010; ILO, 2016). These youth never know where to take their chemistry, biology, physics, agriculture, or geography learned in school and when and how will this knowledge may actually be valuable to their lives. To them, education has not helped them, rather, I would argue, their education has alienated them from their environment, as they feel they do not fit in to village life and yet, have no way to earn a living in the cities and towns! In their needs assessment study for science education in Tanzania, Hamilton et al. (2010) observed:

> …. at both locally and national level…there is a lack of practical application of concepts in science, mathematics and technology in ways that best reflect the nature of everyday problems and challenges in work and society…there are limited opportunities for pupils and students to solve problems or complete projects of the kind they may encounter after completing their studies…yet [these] activities are critical to the development of practical skills required to succeed in the job market…to tackle the kind of real world issues and problems that they will one day face and required to solve (p. 37-38).

I believe, it is only when education, and in this case, knowledge and accompanied ways of knowing become consistent and cohere with the social, economic, political, cultural, and physical context of the learners, when will it liberate them and make them part of the ‘struggling to grow society’. Education has a purpose, to prepare young people to live in and to serve society, and to transmit the knowledge, skills, values and attitudes of the society. If education is not linked to the society,, it impedes the progress of the society, creates ambivalence, and eventually leads to social unrest as people find education has prepared them for a future which is not available to them. Providing children with an education that is irrelevant or one that has no worth for their lives begets a population that is emotionally unstable, socially incompatible, and economically unprivileged and results in a class system of majority 'have nots' and minority 'haves', which our fore leaders worked hard to eliminate, when we became an independent nation(s).

I came to this study, driven by the urge to link school science learning and the society, the actual activities done by the society that can be mutually linked with the school science, and help learners to learn, drawing upon the need to create relevance. Relevance in terms of content, but also in terms of the teaching and learning approaches, linking school science with *Wajasiriamali* production activities to mutually support the school science learning.

Weenie (2008) proposed an aboriginal theory of knowledge and learning, influenced by poststructuralists, postmodern, and postcolonial paradigms, and advised that curriculum should be "utilized as a way of envisioning new possibilities…deconstructing hegemonic discourses, …[and allow] knowledge and ways of knowing to be open to new interpretations" (p. 550). In a country that has recently celebrated a 55th independence anniversary, epistemologically and contextually relevant curriculum and instruction would be worthwhile endeavors. Eliminating the traditional authoritarian and hegemonic curriculum development and teaching process, and opening up new discourses that incorporate voices/views of many, including students and teachers themselves, would perhaps result in a relevant curriculum, one I would call the curriculum of possibilities for the present and future of Tanzania. As a teacher and researcher in science education and curriculum studies, my epistemological outlook, originating from my school and schooling background, is deeply enshrined in these perspectives of knowledge and learning; that is, knowledge and learning is personal but also a social and cultural endeavor that cannot be separated from the context in which it occurs (Greenbank, 2003; Kelley, 2009; Lave, 1997; Savin-Baden & Major, 2013; Sikes, 2010; Wenger, 2000, 2010; Wertsch, 1991).

Thus, consciously knowing my stance and positionality and, being an insider/outsider in my researcher role, I constantly subscribed to both objectivity and subjectivity as I took part in this study (Chiseri-Strater, 1996; Denzin, 2013; Lave & Wenger, 1991). As literature shows, reflecting on and interrogating and conveying researcher's positionality relative to a research orientation is critical to ensuring validity of one's research stance. It is argued elsewhere in the literature that a researcher's beliefs, value systems, moral stances, and even life experiences are fundamentally present and are inseparable from the research process (Kincheloe & McLaren, 2000, 2011; Merriam et al., 2001; Sikes, 2010). I critically reflected upon, and referred to my own positionality at every stage of the research process. In doing so, I constantly asked myself such questions as: how do my personal identities, context, experience, and perspectives were cohering with or diverging from my research inquiry?; and In what ways or not, did I conscientiously or not reifying, resisting or disrupting and/or changing the construct of research? These and many other questions helped me identify, track, and reduce biasness and maintain obtrusiveness in my research and analysis to the best of my ability (Cohen, Manion, & Morrison, 2011; LeCompte & Schensul, 2010).

1.3 Thesis overview

This thesis is organized into six chapters. Chapter one introduces the thesis by providing a rationale for the study, purpose, research questions, significance of the study and researcher background and positionality. Chapter two discusses the theoretical frameworks guiding the study, that is, sociocultural and contextual learning theories. In sociocultural theory the learning occurs within an interactive ecology of social, cultural, and cognitive relations (Daniels, 2001; Lantolf, 2000; Robbins, 2005; Rogoff, 1990). Contextual learning theory regards learning as occurring when learners are able to construct meaning in context in such a way to make sense within their own frames of reference (Hull, 1995; Johnson, 2002). By virtue of theoretical tenets, the two theories complement each other in framing and interpreting a research study on teaching and learning that draws on learners' everyday life local context (Bround, 2004; Martin, 2007; Nashon & Anderson, 2008). Since this study was bringing a new innovation to the research participants, the chapter also reviews the literature related to innovation and teacher change, contextualization of curriculum and instruction and the significance in science learning, as well as an overview of models/different perspectives on contextualization of curriculum and instruction. I also draw upon studies in contextual science learning to identify the literature gap my study will address. Chapter three discusses methodological procedures including context and participants. Chapter four analyses the quantitative and qualitative data sets and presents the study's results, Chapter five discusses the results further in order to relate to and link theory and practice. Chapter six provides a summary of the study and outlines implications for curriculum and instruction, theory, and research, and offers conclusions and recommendations.

Chapter 2: Theoretical framework and literature review

This is a study on science learning that draws on learners' everyday life experiences. Central to this study, is contextualization of a mandated science curriculum where curriculum is interpreted and enacted in ways that link the school science with learners' real world local contexts. In the case of this study, the context is the real world of *Wajasiriamali* manufacturing and processing activities. Research in this case entailed exploration of how these contextualized science curricular experiences influenced students' learning, which in turn, affected their teacher practices of high school science teaching.

Science learning that draws on learners' everyday life experiences, also referred to as context-based science learning, aims to help learners find meaning in the learning process by making connections between the science learned school and the phenomena or activities learners encounter in their everyday life local contexts. While context in this case could be brought into class in the form of examples from real world of the learners', Hull (1995) and Johnson (2002) observe that in most cases, an out-of-classroom field trip is arranged for more concrete learning experiences. In either case, learners are involved in active interaction, co-participation, cooperative and/or joint-construction of knowledge among themselves, and with their teachers, in an attempt to link their prior knowledge and experiences with the ideas and/or concepts that they learn in the school science (Anderson, Lucas, Ginns, & Dierking, 2000; Bebbington, 2004; Nashon, & Anderson, 2008; Parvin & Stephenson, 2004; Tunnicliffe, 2004).

Given the nature of learning, and the context in which this type of learning takes place, it was necessary that research into this area adopted a theoretical framework that is capable of informing the learning that's taking place within social, cultural, and local context from which learners draw their everyday life experiences. As such, I adopted the sociocultural and contextual learning theories as tools to guide the present study. By virtue of their theoretical tenets, studies similar to the present study have shown that the two theories can complement each other in framing and interpreting a research study on teaching and learning that draws on learners' everyday life local environments (Braund & Reiss, 2012; Falk & Dierking, 2000; Martin, 2007; Nashon, & Anderson, 2008). One of the key ideas, as discussed in the next sections, emerging from these theories, is that, learning is seen as both social and cultural activity, involving collaborative co-construction of knowledge between, and among members of the community of practice (Brown & Compione, 1994; Rogoff, 1994). Based on this perspective, knowledge is said to be inextricably bound to social, cultural, historical, and physical context in which it occurs, and that it stretches across the members of the community such that every individual in a particular learning community participates and contributes to the learning of the other (Borko & Putnum, 1998; Cole & Engestrom, 1997; Salomon, 1993).

From the point of view of the two theories, individual, social, cultural and physical environments strongly determine what is learned and how learning will take place (Braund & Reiss, 2004; Hull, 1995; Johnson, 2002). Individuals' motivations, interests, and prior knowledge and experiences are regarded as important factors for learning (Forman, 2013; Hickey, 2003; John-Steiner & Mahn, 1996). The nature of conversation with peers, the interaction with teachers and knowledgeable others, the school norms and expectations, including the norms and expectations of the subject, also account for how learning takes place in and out-of-school learning environments (Braund & Reiss, 2006; Falk & Dierking, 2004). It is in keeping with these views/perspectives that the present study aimed to link the school science with *Wajasiriamali* production activities. I considered the school and *Wajasiriamali* centers as social and cultural milieus in which learners, teachers, and *Wajasiriamali* artisans would meet and interact invariably to form a complex community of learning (Falk & Dierking, 2004; Rogoff, 1995; Wenger, 1998, 2000; 2011).

The purpose of this study was to observe the interaction and learning taking place, and eventually to explore what views/perceptions students and teachers have of how these contextualized science curricular experiences influenced learning on the part of students and teaching on the part of teachers. I made use of these theoretical perspectives in organizing and framing the study, as well as interpreting learners' and teachers' views/perceptions having gone through this approach to science learning. I utilized the perspectives as tools/lens through which to understand the quantitative and qualitative dynamics of the views/perceptions, motivation, and interest, and consequently, learn the value that students and teachers placed on the approach or believed the approach would bring to high school science learning and teaching.

Thus, the present chapter reviews the sociocultural and contextual learning theoretical frameworks while illuminating their assumptions as well as the way in which they link/relate with the learning approach that the present study was espousing; in particular, what is being explored, examined, and measured is identified and linked with these theoretical perspectives. I also illuminate, in a nutshell, the expectancy value theory of achievement motivation as it also informed students' initial reaction toward this learning model. The chapter also reviews literature on various issues informing the results of the study, including literature on students' response to classroom innovations; classroom innovation and teacher change; the meaning, rationale, and various perspectives around contextualization of curriculum and instruction; as well as literature demonstrating the role of context-based learning in promoting relevance and meaningful learning of school science.

2.1 Sociocultural theory

Sociocultural approaches originate from the socio- and cultural-historical work of Vygotsky and his Russian colleagues who first systematized it in the early decades of twentieth century (John-Steiner & Mahn, 1996; Mahn, 1999; Robbins, 2005; Thorne, 2005; Vygotsky, 1978). These approaches are based on the idea that human activities take place in social and cultural contexts, and are, therefore, mediated by language and other symbolic tools for thinking, such as algebraic symbol systems, works of art, writing, schemes, diagrams, maps, mechanical drawings, and all sorts of conventional signs (Vygotsky, 1978; Wertsch, 2000;). According to sociocultural theory, learning is a process of appropriating these tools as they are made available to the learners by social agents, who initially act as interpreters and guides in the individual's cultural apprenticeship (Rogoff, 1990). The theory holds that, it is not just that the child learns from others in social contexts or during social exchanges, but rather, that the actual means of social interaction (the language and symbolic tools) are appropriated by the individual (internalized and transformed) to form the intra-mental tools for thinking, problem solving, remembering, and other such mental activities (Lantolf, 2000; Wertsch, 1985).

Based on sociocultural perspective therefore, the learner is conceived as a cultural and historical subject embedded within, and constituted by a network of social relationships and interactions (Robbins, 2005; Wertsch, 1991). The task of education becomes that of supporting learners' participation in collective or collaborative activities within the community of practice (Lave & Wenger, 1991; Wenger, 2010). The process of learning begins when the learner becomes an active member and a legitimate participant in a community of learning which involves particular ways of acting and knowing, as defined by the culture of the community in question (Lave, 1997; Lave, Smith, & Butler, 1988). These include for example, modes of inquiry, ways of communicating, conventions for presenting ideas, procedures for verifying knowledge and other claims, such as values, beliefs, and general community practices (Goos & Benson, 2008; Goos et al., 2004; Lemke, 2001). Consequently, the role of the teacher, whose instructional activity is situationally defined scaffolds learners' engagement in communal, cultural activities, which involves providing learners with appropriate support and tools they need to help them participate and support each other in meaning-making through collective, collaborative learning activities (Goos, et al., 2004; Hodson & Hodson, 1998; Rogoff, 1990; Wenger, 2011). The teacher's instructional activities then, include directing attention, monitoring ongoing performance, monitoring conversation, and adjusting the degree of assistance, depending on the nature of the activity and the learners' level of engagement (Hodson, & Hodson, 1998; Palincsar, 2012; Palincsar & Brown, 1988). Yet, although the teacher may be seen as an expert in a learning community, meaning-making, which is collective, calls for a space for diverse contribution, expertise, and interpretations that are open to challenge and reconsideration. From the sociocultural perspectives therefore, expertise is seen as a dynamic entity that is distributed over and across members of the community of practice (Brown & Campione, 1994; John-Steiner, 2000; Rogoff, 2008).

Taken together, these sociocultural perspectives were important in framing the present study from the beginning through to data collection, analysis and interpretation of the results. Given that the study entailed to contextualize science curriculum, where, science learning was built around learners' everyday cultural and contextual experiences, sociocultural perspectives were important in providing the lens through which to explore and examine the dynamics of the social and cultural context in which the study was conducted, in order to learn how teachers and students made use of it in enhancing science learning. Martin (2007) observes that the advantage of adopting a sociocultural framework is twofold. First, because it assumes the cultural formation of mind, “it allows us to focus at different levels of learning practices”, for example, “on specific moments of interaction, or on institutional or system dynamics and how these influence the learning processes” (Martin, 2007, p. 254). Second, because the theory views learning as sociocultural practice, and takes into consideration the mediation of tools, language use, participation structures, and social practices, “it allows for comparisons of learning activities or learning systems between and across different learning settings” (Martin, 2007, p. 254). Through the sociocultural framework, Martin (2007) argues that, the teaching and learning practices and the associated behaviors, attitudes, interests, perceptions, and values, can systematically be explored, analyzed, and interpreted within the sociocultural contexts in which they are embedded.

Thus, in framing the analysis and interpretation of the results of the present study, the sociocultural perspective was important in understanding how learners viewed and perceived the science learning experiences that were framed around their culturally and contextually relevant environment, the environment of *Wajasiriamali* production and processing activities. Based on this perspective, it was then, possible to listen, interpret, and make meaning out of their views/perceptions, with regard to the contextual science learning that the present study was implementing.

2.2 Contextual learning theory

Contextual learning theory describes the overall philosophy of learning that relates to hands-on real world experience of the learners, as well as recognizes the fact that learning is a complex process that goes far beyond drill oriented, stimulus-response methods (Hull, 1995).

According to this theory, learning takes place “only when students process new information in such a way that it makes sense in their own frames of reference, that is, to their own inner world of memory, experience, and response” (Hull, 1995, p. 31). Rooted in the work of Dewey (1900s) and Vygotsky (1920s), the theory advocates for active participation in problem-solving and critical thinking, involving *authentic* activities that learners find relevant and engaging (Bruner, 1997). The theory states when learners engage in learning, their minds naturally seek meaning in context, in relation to their current environment, and learners do so by searching for relationships that make sense and appear to be useful (Hull, 1995; Johnson, 2002).

Building upon this understanding, contextual learning perspective emphasizes on multiple aspects of classroom and out-of-classroom real life learning environments such as worksites, industrial sites, museums, science centres, zoos, botanic gardens, residential centers, and other such environments (Braund & Reiss, 2012; Hull, 1995; Lynch, 2002), all of which are important in providing learners with the opportunity to experience and engage in real-world situations, both alone and with others (Karweit, 1993). The theory encourages teachers to “choose, design, and/or [organize] learning environments that incorporate as many different forms of experiences as possible―social, cultural, physical, and psychological―while working toward the desired learning results” (Hull, 1995, p. 32).

At the same time, contextual learning perspectives relate closely with, and draw on other socio-cognitive perspectives in supporting learning in context. Among the perspectives include situated cognition and social cognition (Borko & Putnam, 1998; Johnson, 2002; Lave & Wenger, 1991). Similar to *situated* cognition, contextual learning perspectives hold that both the physical and social contexts in which an activity takes place play an integral part in the learning that occurs within these contexts. It hypothesizes that a relationship exists between the knowledge in the mind of an individual and the situations in which it is developed and used. Theories of situated cognition and contextual learning focus on this relationship, and as Borko and Putnam note, proponents of these theories hold that, "knowledge is inseparable from the contexts and activities within which it develops" (1998, p. 38).

Furthermore, similar to *social* cognition, in contextual learning theory learning is more than just the individual construction of knowledge. In addition to the role the individual plays in facilitating their own learning, contextual learning perspectives recognize interaction with others within social environments as among the major factors that influence both what is learned and how that learning will take place (Johnson, 2002; Borko & Putnam, 1998). Accordingly, the theory holds that participation in a variety of social activities in a community of practice provides cognitive tools, such as new ideas, concepts, and explanations that help learners to make sense out of their experiences (Engestrom & Cole, 1997; Lave et al., 1991; Wenger, 2010).

Taking these various perspectives together, Berns and Erickson (2001) and Johnson (2002, p. 24) suggested that an instruction qualifies as contextual teaching and learning if the instruction: emphasizes problem solving; recognizes that teaching and learning occur in multiple contexts; assists students to monitor their learning so that they can be self-regulated learners; anchors teaching and learning in a diverse array of life contexts of students; helps learners to make meaningful connections; encourages students to learn from each other, that is, collaborate with each other, and; uses authentic assessment. Moreover, according to Berns and Erickson (2001), for students to gain real-life perspectives, contextual teaching and learning must extend across disciplines, knowledge areas, and life situations. Since "real-world situations and problems are rarely represented by one discipline or life situation", contextual learning leads students to seeing "how the knowledge and skills they learn at present in classrooms relates to their lives either now or in the future" by drawing on and relating ideas from various subject or knowledge areas, and learn how these work or apply in real-life situations (Berns & Erickson, 2001, p. 2). Furthermore, according to Hull (1995), contextual learning cycle becomes complete and reaches the strength, personality, learning styles, and interest of all students, when it employs a variety of teaching and learning approaches ranging from collaborative learning strategies such as problem-based learning, project-based learning, cooperative learning etc., and accompanied by "activities that involve doing, watching, thinking, and feeling, [or any] multiple of these" (Hull, 1995, p. 42).

It was assumed in the present study that learning in context and particularly in sociocultural context of the learner, would provide learners with the opportunity to engage with relevant and meaningful learning activities important for them to make connections between their daily life experiences and the school science. Consequently, having experienced relevance and school science, students would attribute positive value to it, choose to follow and deeply engage with it, which, as Gresalf (2009), Moje and Lewis (2007) and Walan and Rundgren (2015) observed, would eventually result into more learning. Drawing on Gardner's theory of multiple intelligences, Falk and Dierking (2002) observed that, since people are born with the potential to develop multiplicities of 'intelligences', and hence, learning styles, a variety of informal out-of-classroom learning environments provide them with the opportunity to pick those situations and experiences that best meet their own personal learning styles. While, for example, some people like to learn spatially by watching, others prefer reading, and yet, others prefer hands-on experiences. In any case, the present study believed that, a variety of informal learning environment that contextualized science learning experiences would provide, would act as a powerful vehicle for supporting diversity in learning styles. Studies on context related science learning (Bennett & Holman, 2002; Lubben, Campbell, & Dlamin, 1996; Nashon & Anderson, 2013; and Zimmerman, 2012) reported students' increased participation and engagement/involvement in learning, increased interest and motivation to learn science, as well as students' appreciation of how meaningful learning contexts changed the way they understood science learning. The present study endeavored to understand how catalytic events that connected classroom science with the real-world contextual learning experiences, positively influenced/affected students' and teachers' views or perceptions towards high school science teaching and learning.

2.3 Expectancy value theory

Expectancy value theory explains how motivation influences individuals' choice, persistence, and performance. Theorists in this tradition argue that individuals' choice to perform a given task or activity and their persistence in it, can be explained by their beliefs about how well they will do the task or activity, and the extent to which they value that particular task or activity (Eccles & Wigfield, 2002; Wigfield & Eccles, 2005; Wigfield & Cambria, 2010). According to the expectancy value theory, behaviour, behavioural intensions, and attitudes are seen as the function of *expectancy* - the perceived probability that an object possesses a particular attribute or that behavior will have particular consequence; and, *evaluation* - the degree of effect, positive or negative towards an attribute or behavioral outcomes (Palmgreen, 1984).

Based on the model Eccles and Wigfield (2002) developed to elaborate the theory, expectancies and values are assumed to influence directly achievement choices, performance, efforts, and persistence, while at the same time, influenced by task-specific beliefs such as ability beliefs, perceived difficult of different tasks, and individual's goals, self scheme, and affective memories (Eccles & Wigfield, 2002). From the point of view then, individuals' behaviour becomes a function of the expectations they have and the value of the goals or outcomes they are working toward. In other words, people's decision to engage with a task or an activity will always depend on the belief there are advantages in executing the task, and the belief they can succeed.

Literature shows that various researchers in teaching and learning have used the expectancy value theory in informing their studies on innovation in learning. More particularly, the theory has been used as a lens to explore, interpret, and analyze, students' and teachers' views/opinions, perceptions, attitudes, aspirations, and similar attributes, towards various classroom innovations, and mainly, the newly introduced teaching and learning innovations (Ball at al., 2016; Charles & Issifu, 2015; Guo et al., 2017; Purvis, et al., 2015). Charles and Issifu (2015) for instance, employed the expectancy value theory in exploring students' perceptions of the newly introduced ICT program in secondary schools in Ghana, the study which revealed differences in response between male and female students, as well as between public and private school students. Likewise, Guo et al. (2017) used expectancy value theory in studying how students' self-concept and value related to their achievement and aspirations in four science domains – physics, chemistry, earth science, and biology. The study found the interaction between self concept and intrinsic value predicted the students' aspirations towards the subjects. Expectancy value theory was also used by Ball et al. (2016) in exploring students' intension and motivation to continue with computing science program in their further studies, and also in associating intension and motivation to continue with the program with success and subjective values. The study found that changes in students' subjective values having gone through the program was positively associated with students' intension and motivation to persist in the program, and more importantly, to persist in academia.

Since it was the first time students in the present study were encountering contextualized science learning experiences, and based on their initial responses/ pre-experience questionnaire and interview responses, it was necessary that a theory informing students' initial reaction/responses towards innovation was adopted. The expectancy value theory was thus, found to be a perfect theory as it explains the reasons why participants in an innovation would respond in certain ways. Students in Ball et al.'s (2016) study seemed to associate the subjective values of the program with their intention to take up and persist in the program. And this was important information towards the improvement of the program. Guided by the expectancy value theory in the presents study, students' initial responses towards contextualized science learning were considered of value, taken up, and used to modify and improve the contextualized science learning experiences prior to and during implementation of the study.

2.4 Summarizing the theoretical framework

The first three sections in this chapter reviewed the three major theories used together in this study as interpretive lens through which to understand the research data. These included sociocultural theory, contextual learning theory and expectancy value theory of achievement motivation. Key ideas in the theories were illuminated and their implications for learning highlighted. Thus, while the sociocultural theory sees learning as both social and cultural activity, involving collaborative co-construction of knowledge between and among members of the community of practice (Brown & Compione, 1994; Rogoff, 1994), and that knowledge is regarded as stretched across the members of the community such that each member participates and contributes to the learning of the other (Borko & Putnum, 1998; Salomom, 1993; Cole & Engestrom, 1993), the contextual learning theory conceives learning as occurring when learners are able to make sense of what they learn in their own frames of reference (Hull, 1995). According to contextual learning theory, meaningful learning takes place only when learners are able to see the relationships and uses of what they learn in school to activities in their everyday contexts, and through such activities as out-of-school field trip experiences, learners organize what they learn in different contexts not only so that it relates to their everyday encounters (Braund & Reiss, 2004; Lynch, 2002) but also so that it broadens their ability to discover relationships and make connections between abstract concepts that they learn in the school science classrooms and their application in the real-world settings (Hull, 1995; Johnson, 2002). Whereas sociocultural theory focuses on tools of learning such as language and other verbal and nonverbal mediations as key in enhancing interaction and learning across the members of the community of practice (Daniel, 2001; Kozulin, 1998; Lantolf, 2000; Smith, 2006; Vygotsky, 1978), contextual learning theory focuses on learning contexts and how these influence the whole process of learning. More specifically, how learners arrive at learning when subjected to different types of contextually relevant learning contexts (Braund & Reiss, 2004; Hull, 1995; Lynch, 2002).

Given the nature of the present study, the theoretical framework takes into account both the social and physical aspect of learning, that is, the interaction among the learners, the teachers, the learned materials, and the environment within which this learning was taking place was hired. Although in sociocultural theory learners are social and cultural individuals, and learning is a process, the nature and the environment or the context in which this process may occur is not specific, and more importantly, nor is how this context influences learning. This necessitated the incorporation of the contextual learning theory which explains how the process of learning was occurring in that particular context of the present study.. Literature clearly states that learning cannot be separated from the context in which it occurs (Braund & Reiss, 2004; Falk & Dierking, 2004). Moreover, individual, social, cultural and physical environments are said to strongly determine what is learned and how that learning will take place (Rogoff, 1995; Falk & Dierking, 2002). Since the present study considered learning as both the individual and group experience occurring within learners' everyday local context, the combination of sociocultural and contextual learning theories was important as it informed the examination of learning that was taking place within individuals and in groups in both school and out-of-school learning settings, or in other words, learning that was taking place at individual, interpersonal, and community levels.

Consequently, the combination of social cultural theory and contextual learning theory acted as a lens through which to examine learners' dynamics of perception, motivation, emotions, attitude and interest in learning science at school as well as with *Wajasiriamali* during out-of-school study visits, and together, the theories were used deductively to trace how learners gradually recognized, evaluated, and revised their personal frameworks as they engaged in learning through relating the school science with their everyday life experiences in different contextually and socially situated learning settings. Based on these frameworks, it was possible to explore learners' engagement in dialogue and conversations, their mutual involvement in activities, the way they developed shared understandings, and eventually, the way together these shaped their ideas, beliefs, and practices throughout the study. In the end, it is the combination of the two theories, the sociocultural and the contextual learning theories, that guided the understanding of the complex nature of learning taking place within the contextualized science learning environment, and eventually, helped in interpreting the views and perceptions students held of the effect of this approach on their own learning, having gone through the study.

In addition to exploring how students viewed and perceived the effects of contextualized science curricular experiences, the use of sociocultural and contextual learning theories in combination was also important in exploring how the school-*Wajasiriamali* learning experiences impacted on the philosophy and practices of teaching and learning held by teachers, as well as the value that teachers placed on this approach to science learning. This was examined through investigating their preferred methods of teaching having gone through the study; how they understood and interpreted learning in different contexts; the tools that they choose to support learning; as well as their responses in terms of motivation, and perceptions towards this approach to science learning (see also Robbins, 2005).

Since contextualized science learning was a new approach to science learning to the students involved in this study, students' initial responses/reactions towards the approach prior to implementation of the study necessitated the incorporation of a theory that explains how learners respond to learning innovations newly introduced to them. As it will be seen later in the data analysis and discussion chapters, students raised a number of questions and required explanations related directly to their expectations regarding this approach to science learning before implementation of the study. The students' response called for the adoption of the expectancy value theory of achievement motivation which was useful in explaining how and why learners made choices when subjected to a variety of learning options, and in this case, the traditional versus the contextualized science learning approach.

2.5 Innovations in teaching and learning

> In order to meet the needs of a changing society of today, “the education system itself must develop qualities of flexibility and adaptations, so that instruction and experiences offered are meaningful to students and relevant to their life situations (Miles, 1964, p. 14.)

Miles (1964) defined innovation as a deliberate, novel, specific change, which is thought to be efficacious in accomplishing the goals of a system. In education system, he adds, it intends to help the education system to come to term with the problems that it faces. According to Serdyukov (2017), since education is a social institution serving the needs of the society and is therefore indispensable for the society to survive and thrive, it should not only be comprehensive, sustainable, and superb, but also, evolve continuously to meet the challenges of the fast-changing society. According to Cuban (2001, 2013) three main goals characterize the need for innovation: (1) making school more effective and productive; (2) transforming learning in an engaging and active process connected to students’ real life outside school; and, (3) preparing the new generations for the future job market. The present study focused on the later two aims of innovation in education, to transform learning in to a real, active, and engaging endeavor, as well as making it relevant to current and future needs of the learners.

Literature identifies various stages through which innovation in teaching and learning may navigate in order to be successful (Kwek, 2011; Nisbet & Collins 1978; Sedyukov, 2017). The commonly mentioned stages include: i) development of awareness and interest to both teachers and learners; ii) collaborative evaluation of potential in terms of rewards and costs; iii) actual trial in classroom; and finally, iv) decision to adopt or reject the innovation. However, simple as the stages may be, Fullan (2007), Kwek (2011) and Nisbet and Collins (1978), agree that change is not as simple as it may seem. Given the fact that educational innovation may be part of or involve one to several of the following: new policy; new syllabus; new methods; new educational ideas or practices; adaptations, extensions or modifications of earlier ideas; changed conditions of learning; change of attitudes and perceptions; new situations and requirements of results and so on, innovations might take weeks to several years before they become part of what the society intended. In fact, several reasons have been outlined (Carter, 2008; Eisner, 1992; Fullan, 2007; Kwek, 2011; Miles, 1964; Sedyukov, 2017) that explain why classroom innovations may not go through as perfectly as intended. Among other things, include: dispute over specific educational objectives related to the innovation; inappropriate motivation; characteristic of the school systems which are not receptive to change; characteristics of the innovation which hinders adoption; and, characteristics of persons associated with the innovations, that is, teachers, students, and school administrators. Hoyle (1972) and Kwek (2011) summarized these barriers as attitudes, resources, and organizational structure. And of these, the most significant factors are attitudinal which stem from personal, emotional, and cognitive reactions to change. As such, Hoyle (1972) made a point that classroom innovators must consider all of these factors and make allowances for them, if the innovation is to have any chance to succeed.

Nisbet and Collins (1978) observed that regardless of the drive, commitment, and motivations of the developers and/or change agents, it is the users, the teachers and students, who must ultimately adopt, adapt, or reject the innovation. Faced with new pedagogical orientations, new curriculum, and new educational technology, teachers, as well as students, choose what suits them at certain context in a given time or situation (Sarason, 1996; Tomasetto, 2003). Eventually, it is the way in which classroom innovations are introduced, their positive values associated with the teaching and learning, and the outcomes thereof that will increase the likelihood that the innovations will go through and be adopted (Serdyukov, 2017).

2.5.1 Innovations and teacher change

Teacher change is generally defined as change in classroom practices of teachers, in their attitudes, beliefs, and perceptions, and, eventually, in the learning outcomes of their students (Guskey, 2002; Hargreaves, 1996; Holloway, 2010; Lieberman & Mace, 2008). In the context of educational innovation, teacher change, according to Tomasetto (2003), is seen as both individual and social process, a gradual and complex phenomena, which calls for consideration of different ways people form and change their attitudes, knowledge, and skills in the social world by their exposure to other peoples' skills, knowledge, and attitudes (Also Giacquinta, 1998; Guskey, 2002; Zwart, et al, 2008). Tomasetto (2003) continues to argue that because teacher change is both individual and social process, limiting ourselves into only individualistic approach to what teacher change is, will result into blaming teachers for refusing to implement valuable forms of classroom innovations, or for preventing deeper change in education to occur as we want. Such approach, he cautions, neglect the evidence that a teacher is part of a social system in which s/he play a role and that this role is defined by social construction as they interact with other people in the school or in other related social settings (Tomasetto (2003). Elaborating on a similar point, Lieberman and Mace (2008) posited that teachers learn from others in particular ways, for instance, "through practice (as they learn by doing), through meaning (learning as intentional), through community (learning as participating and being with others), and through identity (learning as changing who we are)" (p. 227). Given this, classroom practices, according to Lieberman and Mace (2008), should be rooted in human need to feel a sense of belonging and making contribution to a community where experience and knowledge function as part of the community property. This way, classroom practices aimed to improve teacher learning/change, become effective if oriented towards building collaboration among teachers, if not the community of practice (see also McLaughlin & Talbert, 2006; Williams, et al., 2006).

Looking at teachers as the main mediators between curricular reforms and school practices, Ariza and Gomez (1992) pointed out that teachers mediate between educational acts and the process of teaching and learning in a double process. On the one hand, they use cognition to translate, analyze, and evaluate contributions that they receive from outside their own structures of knowledge, be it educational models or curricula instructions. In other words, teachers have a system of beliefs and personal constructs about teaching which operate as cognitive filters or sometimes as cognitive obstacles. On the other hand, Ariza and Gomez (1992) observe that teachers are like practitioners in class who make many decisions about their own behaviour. While this behaviour is influenced by their belief system and opinions, it is not automatically adaptable, rather, influenced by diverse variables, emotional, cognitive, and attitudinal, all of which interact in specific context to shape their classroom practices and determine if they change.

Given the nature of teacher change then, what attracts teachers to engage in innovative classroom practices is their belief that it will expand their knowledge and skills, contribute to their growth, and enhance their effectiveness with students (Borko, 2004; Goodson, Moore, & Hargreaves, 2006; Guskey, 2002; Tomasetto, 2003; Olsen & Sexton, 2009). Contrary to this, it is highly unlikely that an innovation will be adopted by teachers (Guskey, 2002).

According to Olsen and Sexton (2009), the more the adoption of an educational tool is perceived as difficult to manage, the more the teachers will likely refuse it, as the tendency is to avoid any possible failure that may lead to threatening their positive professional identity. At the same time, Tomasetto (2003) posits that teachers may hesitate or resist adopting an innovation because of the differential status between them and the source of the innovation. The asymmetry of power could induce into teachers, the refusal attitude, which is meant to just refuse the source's viewpoint in order to maintain their autonomy or status quo (Olsen and Sexton, 2009). In this case, rather than attempting to convince teachers as to the goodness of an innovative educational practice, Guskey (2002) proposed that the best way is to find out ways to implement the practice successfully because teachers' change of perception, beliefs, and attitude is highly dependent upon the successful implementation of the practice. To Guskey, practice first, and the change comes next and gradual. And this is consistent with other researchers in teacher development and learning (Ball, 2000; Elmore, 2004; Fullan, 2016; Huang & Shimizu, 2016; Zeichner, 2003), who also believe that teacher change is gradual and is enhanced by the successful implementation of the innovative classroom learning reform practices.

2.5.2 Student response to classroom innovations

As noted earlier, one main aim of classroom innovations is to improve students' learning, and eventually, learning outcomes. Faced with innovative classroom practices, studies indicate students may follow one or more of the following directions in response to the innovation. They may accept and adopt the innovation for the betterment of learning; or, may demonstrate reluctance or become passive about the innovation; or, resist the innovation completely (Seidel & Tanner, 2013). Students passivity or resistance to classroom innovations have been generally associated with among other things, the situation that causes frustrations to students, upset, and/or disengagement with what is happening in the classroom during the implementation of learning projects (David et al., 2017; Goodboy, 2011; Seidel & Tanner, 2013). More specifically, literature shows that the passivity or resistance to learning innovations could be associated with poor organization of learning activities associated with the innovation, especially in densely populated classrooms; poor and unmanaged interaction between individual students and their classroom peers as a result of increased classroom collaboration demanded by many pedagogical innovation practices; social barriers due to the nature of students within groups, and especially when accentuated by the group size; comparative learning benefits associated with the innovation; instructors unavailability or inaccessibility especially outside of class hours, and so on (Aggarwal & O'Brien, 2008; Brookfield, 2006; Anderson, Thomas, & Nashon, 2008; Prince & Felder, 2007).

At the same time, students' acceptance or adoption of innovations have been linked with clear explanations to students as to the reasons a particular pedagogical innovation is being introduced; organization of the groups during collaborative learning in such a way to maximize positive interactions among the group members; variation or flexibilities in the teaching -learning strategies aimed to accommodate a variety of learners during the course of implementation of the projects, and similar contextual factors (Seidel et al, 2015; Seidel & Tanner, 2013). According to Seidel and Tanner (2013), different teaching approaches and hence strategies, are likely to resonate in different ways with different students. As such, variation of teaching-learning strategies/techniques that go along with the new pedagogical innovation will likely bring a variety of students in to their comfort zone, hence reduce the likelihood that they will oppose or behave passively when implementing the innovation.

In a study promoting learner-centered learning in their classrooms, Girgin and Stevens (2005) devised various mechanisms to encourage students' participation and adoption of the innovation they were implementing. The researchers ensured students' participation and involvement in learning was part of their final evaluation. This included participation or involvement in activities, as well as contribution to the discussions that went on during group tasks. Students feeling their minor involvement and contribution to learning counted in their final grading, was found to be motivating and subsequently encouraged more participation and a sense of the importance of learner-centered learning of the innovation. In addition, employment of a variety of specific strategies to accommodate differences in students learning such as think pairs, discussion roles, fishbowls, case studies, and small group presentations, played a major role in encouraging participation in various ways so that every student had an entry point through which to take part in learning (Girgin & Stevens, 2005).

Caprio, Powers, Kent, and Harriman, et al. (1998) took a step to transform their teaching from lecturing and note giving to a constructivist classroom approach in their science courses using collaborative learning strategy. The instructors found that, students demonstrated some reluctance at the beginning of their transformation because they were accustomed to the traditional approaches to science teaching. However, interviews with their students conducted at the end of the term showed that students were very much transformed and enjoyed the approach. Among the reasons students provided was that the approach gave them a chance to discover new information very much valuable to their learning, unlike the traditional approach which made them rely solely on the lesson notes provided by teachers. Moreover, students revealed they deeply enjoyed the mutual respect between themselves and their teachers, unlike the old traditional approach. Also, despite having more work to do compared to their friends in traditional classes, a constructivist approach helped them retain more information as they explored and discovered, which was very much motivating to them (Caprio, et al., 1998).

In the context of new classroom practices, Hancock (1995) pointed out that teachers need to create the environment likely to maximize students' motivation to learn. Connecting the expectancy value theory with how teachers could motivate students to keep learning in the context of an innovation, Hancock (1995) suggested teachers may elect to influence one or more of the three components of the expectancy value theory, the expectancy, the instrumentality, and/or valence. With regard to expectancy, Hancock suggested teachers may need to make it clear to students those behaviours in the new teaching-learning approach associated with meaningful learning and clarify to students how their behaviours may result in successful accomplishment of their goals. Furthermore, he suggested teachers may need to provide additional instructions regularly as the implementation of the new classroom practice progresses, especially if students demonstrate the feeling that the quality of instructions regarding the practice is inadequate. Moreover, Hancock (1995) proposed to teachers, to restructure or reorganize students learning environment, in a regular basis, in such a way to foster students' perceptions that behaviors associated with the new learning practice are accomplishable.

On the other hand, in order to influence students' instrumentality, the subjective estimation of the likelihood that a particular behaviour will result in certain outcomes, Hancock (1995) pointed out that teachers may choose to highlight/clarify how learning through the selected approach might lead to better understanding of the materials and eventually better performance in their exams.

As for valence - the positive or negative value students attach to what they learn - Hancock (1995) suggested teachers attend to different values that students place on the outcomes associated with the type of learning of the new practice. According to expectancy value theory, students attach different values to different learning outcomes. For example, some students learn to get “A” grades, while others learn for the purpose of understanding the materials regardless of grades, and others learn for both understanding of the materials and grades. Yet, others have no clear focus (Ames, 1992). Hancock (1995) states if an innovation is to be adopted by students, the role of the teachers is to recognize and attend to these individual differences as they attempt to implement new classroom practices.

2.6 Contextualization of science curriculum and instruction

This study is an exploration of the effect of contextualized science curricular experiences on students’ learning, which in turn, affects their teachers’ teaching. In this section of the literature review, I illuminate three important aspects relating to the central theme of the study, which include: the literature describing the foundation of and the various meanings attached to the term ‘contextualized curricular experiences’ or the ‘contextualized learning’; literature describing the rationale behind contextualization of science curricular experiences, including its potential to promote meaningful learning of the school science; and literature illuminating different models/forms that the contextualized science learning could take.

2.6.1 On the meaning of contextualized curricular experiences

Literature shows that teachers often face the challenge of how to best convey the many concepts they teach in class so all students can use and retain them (Solomon & Aikenhead, 1994; Hull, 1995; Johnson, 2002). Teachers have been confronted by questions about how effectively they can communicate with students who do not see the reasons for and the relevance to their everyday lives of what they learn in school (Hull, 1995). One way teachers could face these challenges successfully is through developing and implementing contextualized curricular experiences, a mode of learning that entails bringing the mandated curriculum to the context of the learners (Berns & Erickson, 2001; Del Rosario, 2009; Kelley, 2011).

The idea of contextualization of curricular experiences is not without precedence as much of its origin stems from the work of John Dewey, the progressive educator and philosopher. Dewey embodied the principles of contextual learning, and most fundamentally, the “idea that there is an intimate and necessary relation between the processes of actual experience and education” (Dewey cited in Weinbaum & Rogers, 1995, p. 4). While reacting strongly against the rigid rote curriculum of his day, Dewey advocated for a curriculum and instructional methods that tied children’s experiences and interests together. He criticized the separation of education into mind and body and of school programs into academic and manual tracks (Weinbaum & Rogers, 1995). Throughout his writings, Dewey continued to urge that education and learning be social and interactive processes, wherein learners are provided with the opportunity to experience and interact with the curriculum as they take part in their own learning. According to Dewey, in order for education to be effective, content must be presented in ways that allow students to relate the information to prior experiences, thus deepening their connection with the new knowledge (Dewey, 1902). Furthermore, as one of the most famous proponents of hands-on learning or experiential education, Dewey believed “if knowledge comes from the impressions made upon us by natural objects, it is impossible to procure knowledge without the use of objects which impress the mind” (Dewey, 2009, p. 217-218). He therefore, advocated for an educational structure that strikes a balance between delivering knowledge while also taking into account the interests and experiences of the learners.

Building upon the ideas of Dewey, scholars have perceived and explained the meaning of contextualized curricular experiences in many different ways, all in an effort to try to understand and improve children's learning (Berns & Erickson, 2001; Hull, 1995; Lynch, 2002; Mason, 2004). Lynch (2002) for example, described contextualized curricular experiences as providing students with the opportunity to employ their academic understandings and abilities in a variety of in-and-out-of-school contexts to solve real-world problems. According to Lynch (2002), through this type of instruction and learning teachers are able to help students make connections among their roles and responsibilities as students, citizens, workers, and productive members of society. Lynch characterized contextualized curricular experiences as involving: problem solving; self regulation; a variety of contexts, including worksites and the community; teams of learning and working groups; being responsive to a host of diverse learners' needs and interests; and possessing all skills that can serve students well in later life (Lynch, 2002).

On the other hand, Hull (1995) in his attempt to advocate for the connection between school learning and students' future careers described contextualized learning as creating the environment in which the connection between academic concepts and workplace and vocational skills is a central focus. According to Hull, this approach to learning focuses on multiple aspects of knowledge, as well as learning environments and allows teachers to "choose and design learning environments that incorporate as many different forms of experience as possible, including social, physical, and psychological, while working towards the desired learning outcomes" (Hull, 1995, p. 32). Through this type of learning, Hull (1995) observed that students are able to: discover relationships between abstract ideas and real-world applications in their context; internalize concepts as they discover, reinforce, and connect the relationships; and apply the knowledge they get throughout their lives and careers.

While Berns and Erickson's (2001) definition of contextualized learning does not seem to differ greatly from Hull's (1995) and Lynch's (2002), Berns and Erickson went further to identify the theoretical underpinnings that support 'contextualized learning' as a legitimate curriculum and instructional approach. They defined contextualized learning helping teachers relate subject matter content to real world situations and motivating students to make connections between the knowledge learned in school and applications in their real lives, both during and after school. According to Berns and Erickson (2001), this type of curriculum helps students find meaning in the learning processes by "connecting the content they are learning to the real life contexts in which that content could be used" (p. 2). Therefore, students draw upon their previous experiences and build upon existing knowledge as they strive to attain their learning goals (Berns & Erickson, 2001).

Borrowing from Resnick and Hall (1998) and Borko and Putnam (1998), Berns and Erickson (2001) identified several examples of theories and themes that support the use of contextualized learning as a legitimate approach that can be used with students. According to Berns and Erickson (2001), contextualized learning adheres to and is in line with the following theories of learning:

- *Theory of constructivism* - learners are involved in construction of their own knowledge as they strive to achieve goals;

- *Effort learning or incremental theory of intelligence* - learners engage in activities with a commitment to learn, which increases their abilities and intelligence;

- *Socio-cultural theory* - students learn the standards, values, and knowledge of society by raising questions and accepting challenges, as well as finding solutions that are not immediately apparent, along with explaining concepts, justifying their reasoning, and seeking information;

- *Theory of situated learning* - knowledge and learning are believed to be situated in particular physical and social contexts so that a range of settings such as home, community, and workplaces, and other out-of-school learning environments are used, depending upon the purpose of the instruction and the intended learning outcomes; and
- *Theory of distributed learning* - knowledge is viewed as distributed or stretched over the individual, other persons, and various artifacts, such as physical and symbolic tools, and not solely as a property of individuals (Berns & Erickson, 2001, p. 2)

Working together, the theories identified by Berns and Erickson (2001) serve as the underlying principles for the contextualized learning approach. In fact, Hull (1995) added to Gardener's (1983) theory of multiple intelligence when he argued contextualized learning also entails to take care of learners' multiple intelligences. He also added Kolb's (1984) learning theory which holds that learners tend to perceive information either abstractly for example. by conceptualizing or thinking or concretely by experiencing or doing. Given that most students do not fit neatly into only one of Kolb's categories of learning, Hull (1995) argued that, through contextualization of learning the strength of all students is reached, as this approach employs a variety of settings that provide spaces for "interpersonal communication, group learning, sharing, mutual support, team process, and positive reinforcement" (Hull, 1995, p. 43).

From the definitions and the theoretical support provided by various scholars above, contextualized learning/ or contextualized curricular experiences could be considered as providing opportunities for learners to connect what they learn in school with what they experience in their everyday life environments. As well, in a more comprehensive way, providing learners with the opportunity to actively engage in learning, challenge ideas, reflect, and make connections between the knowledge they learn in school and their everyday experiences, through a variety of in-and-out-of-school learning environments (Berns & Erickson, 2001; Bround & Reiss, 2012; Hull, 1995; Lynch, 2002).

2.6.2 Potential for contextualized curricular experiences to promote meaningful learning of the school science

As noted in the previous section, the important element of contextualized curricular experiences involves learners actively connecting the school knowledge with the knowledge they obtain from their everyday life experiences. In addition, learners have a sense of ownership of the subject and feel responsible for their own learning (Del Rosario, 2009; Gilbert, 2006; Parchmann et al., 2006). The combination of self-directed learning and the use of context are consistent with constructivist views of teaching and learning (Gilbert, 2006). Thus, implementing contextualized science curricular experiences with students is in line with the contemporary research in science education that points to the need for learners to construct their own meanings, from their experiences, through interaction with the environment (Cakir, 2008; Driver, Asoko, Leach, Mortimer, & Scott, 1994; Bennett, 2003).

As indicated elsewhere in the literature, the argument for the teaching of science through traditional decontextualized approaches has been based on the premise that students need some content knowledge of the body of facts, concepts, laws, and theories of science before they can deal with problems that involve complex scientific solutions (Bennett, Lubben, & Hogarth, 2007; Fensham, 2004; Hamilton et al., 2010; Knamiller, Osaki & Kuonga, 1995; Koul, 1997; Lindahl, 2003; Lyons, 2006; Osborne & Collins, 2001; Sheldrake, Mujtaba & Reiss, 2017). Several contradictory arguments have been raised, including the statement that when the learning of science begins with ‘closed definitions’ of concepts and laws of science, students feel they must look only for ‘right’ answers and conclusions (Aikenhead, 2006; Bennett, Lubben, & Hogarth, 2007; Koul, 1997; Verma, 2001). When this happens, teaching science becomes analogous to training students to memorize specific concepts, with no reference to their prior knowledge and experiences, which results into students viewing science as separate from everyday activities (Bround & Reiss, 2012; Hampden-Thompson & Bennett, 2013; Koul, 1997). On the contrary, teaching science in context illuminates the theoretical practices of science, technology and the society, and justifies and gives meaning to theory by demonstrating it in specific context and situations (Bround & Reiss, 2012; Sheldrake, Mujtaba & Reiss, 2017).

In addition, according to Lave (1993, 2009), rather than the discrete and deterministic entities found in traditional decontextualized science, context and activities in contextualized learning provide a flexible and changing learning environment. Thus, with contextualized learning, students take part in activities with their thought processes engaged in the content and context of the problem (Bennett, Lubben, & Hogarth, 2007; Lave, 2009; Rugoff, 1984; Verma & Habash, 2005), where the context comprises “the problem’s physical and conceptual structure, as well as the purpose of the activity and the social milieu in which [the activity] is embedded” (Rugoff, 1984, p. 3).

Traditional decontextualized science learning has also been criticized for a tendency to replace a person’s intuitive knowledge of the world with formal-problem solving procedures; thus, ignoring the prior knowledge and experiences of both students and their teachers (Graham, 2011; Specht, 2008). On the contrary, contextualized science instruction recognizes the sociocultural dimensions of problem solving and makes it easier for students to connect with their prior experiences (Specht, 2008). Moreover, this approach encourages students to articulate or construct meanings in specific situations (Bround & Reiss, 2012), thus welcoming improvisation and open-endedness, acknowledging ambiguities, and giving voice to the subjective and social experiences of the students (Hampden-Thompson & Bennett, 2013; Koul 1997). Solomon (1996) argued that the job of science education should be to help students learn how to find solutions to problems in different contexts in meaningful ways.

Another strength is contextualized science learning experiences allows for the use of a variety of strategies in exploring areas of conceptual conflict as well as debatable issues in science, technology, and society (Aikenhead, 2006; Campbell and Lubben, 2000; Graham, 2011; Del Rosario, 2009; Verma, 2001). Verma (2001) for example, observed that, through contextualized learning, students could begin with activities that capture their interest in learning a specific aspect of science, and thereafter, elaborate, review, and reflect on their results for the deeper understanding. Similarly, Campbell and Lubben (2000) observed that, in contextualized science learning, a lesson could start with an invitation to speculate about the possible explanation of an everyday situation, which allows the conceptual development to follow naturally from the learners' current understanding. A speculation phase, according to Campbell and Lubben (2000), would provide teachers with the opportunity to identify misconceptions, which they could then systematically address in the subsequent stages of learning. Amidst these approaches, students have the opportunity to refine and reformulate their ideas and possible explanations regarding the phenomena around them through participating directly in the construction of knowledge in the actual contexts. According to Del Rosario (2009), when students get the opportunity to create and participate in contextualized learning, they learn better and have the chance to take on a more creative learning role.

On the other hand, Bround and Reiss (2004) argue while some students learn better through words (auditory learners), others learn better through pictorial imaginations (visual learners), while others learn best through physical activities (kinesthetic learners). The diversity of experiences and activities afforded by out-of-classroom science learning contexts offers the opportunity for a greater inclusion of learners with different learning preferences and styles. Moreover, Wellington and Britto (2004) observe that, learning in context allows for greater student autonomy, as it is “more learner-centered, voluntary, intrinsically motivated, open access, and less structured” (p. 212). According to Wellington and Britto (2004), this approach not only entails a geographical shift in the site of learning, but also, encourages a shift in the culture of learning, in which teachers as well as students increasingly realize and appreciate the importance of ‘place’ in science learning.

2.6.3 Models/ Perspectives in contextualization of science curricular experiences

A range of perspectives are available to describe various forms and ways in which contextualized science curricular experiences could be organized and implemented (Aikenhead, 1994; Johnson, 2002; Hull, 1993; Hull, 1995). While some of these perspectives relate exclusively to the forms used to organize the curriculum, others relate to the instructional strategies involved in learning in context.

One of the most commonly cited curriculum typology that shows the different ways in which teachers can link the traditional school science curriculum with learners’ everyday experiences was developed by Aikenhead (1994). The typology, which he called the ‘integrative structure' of school science, presents eight possible types of curricula grouped according to relative proportions between traditional school science content and Science Technology and Society (STS) content, which represents the context from which learners draw most of their everyday experiences. The eight categories of curricula include: i) School science curriculum motivated by STS content; ii) School science curriculum casually infused with STS content; iii) School science curriculum purposefully infused with STS content; iv) Singular discipline through STS content; v) Science curriculum through STS content; vi) Science along with STS content; vii) Infusion of science into STS content; and viii) Entire curriculum made up of STS content (Aikenhead, 1994, p. 54).

In clarifying his curricula typology, Aikenhead (1994) observed that the proportion of school science content to STS content decreases as one moves from category one to category eight on the spectrum. For instance, whereas in categories one to three, the selection and sequence of science content follows — and is dictated by — traditional school science, from categories four to eight, the curricula structure changes dramatically and becomes one in which the organization of science content follows a sequence dictated by the STS content (Aikenhead, 1994). Hence, in category one, STS is mentioned only to make the lesson interesting; in category two, STS is attached to some science topic; whereas in category three, a series of STS topics are attached to traditional school science in order to systematically explore the linkages between the school science and the STS (Aikenhead, 1994, p. 55).

However, from categories four to eight, the amount of STS content increases as the traditional science content decreases (Aikenhead, 1994). Thus, in category four, STS content serves as an organizer of the science content and the school science content is selected from one science discipline; in category five, STS organizes the content and the school science content is selected from various science disciplines; in category six, STS is the focus of instruction, with some relevant school science content to enrich the learning; in category seven, STS is the focus of instruction with a mention of some school science content, not systematically taught; and finally, in category eight, a major technology and/or social issue is taught with a mention of school science content only to show an existing link to science (Aikenhead, 1994, p. 56).

In a similar trend, the proportionality of content between traditional school science and STS is also reflected in the assessment and evaluation of students (Aikenhead, 1994). Whereas in category one students are not assessed in the STS content, in category four, assessment could carry 20% STS and 80% school science content. In category seven, students could be assessed by 80% STS and 20% school science content. In the last category, students are not assessed on pure science content to any appreciable degree; instead, most of the assessment tasks come from STS content (Aikenhead, 1994).

The curricula typology proposed by Aikenhead (1994) was reinstated by Kasanda et al., (2005) in a much more simplified and user-friendly typology, in which the eight categories were compressed into three categories namely: *context-infused* curricular experiences — in which science subjects incorporate issues from society and/or technology; *context-based* curricular experiences — in which science subjects are taught through discussion of issues from society and/or technology; and *context-focused* curricular experiences-in which courses about issues in society and/or technology are taught with some inclusion of traditional school science content (Kasanda et al., 2005, p. 1805). Therefore, in the first category in Kasanda et al.'s typology, traditional school science dictates the curricular experiences while issues from the society and technology are drawn on to exemplify and make science learning more interesting. In the second category, traditional school science dictates the curricular experiences while issues in society and technology are used to teach specific ideas or concepts from traditional school science. And in the third category, issues from society and technology (STS) dictate the curricular experiences while traditional science is included only to show some relevance or link with the school science (Kasanda et al., 2005).

Johnson (2002) identified six ways contextualized curricular experiences could be organized to make an effective connection between teaching and learning and students' daily life contexts. Contrary to Aikenhead's (1994) typology, which explicitly focuses on curriculum organization, Johnson's classification, which she called "the most effective methods of bringing together academic content and context of students' personal experience" (p. 49), centered around the organization of classroom instruction for effective contextualized learning. Included in Johnson's (2002) classification included six categories of methods: the traditional stand-alone classrooms that connect material with the students' context; the infusion into a stand-alone class of material from another field; linked subjects that remain separate but cover related topics; the integrated course bringing together two or more subjects into a single class; combining school and work; and finally, service learning (Johnson, 2002, p. 49).

According to Johnson (2002), regarding the *traditional stand-alone class*, the teacher connects new information with students' life in a myriad of ways that echo meaning. For example, a teacher could begin by describing a particular complex but interesting idea, concept, or topic and invariably ask the class open ended questions designed to prompt vigorous discussion about how the idea could be tied to students' own experiences. Divided into groups, the students would then discuss their experiences of how they connect with the idea and eventually share with the whole class (Johnson, 2002). Other strategies in this category could involve: inviting a guest speaker to talk about the material or the topic in the context of a real life experience; asking students to teach part of the topic by drawing on their own experiences; teaching the material in ways that appeal to multiple intelligences and different learning styles; and doing a variety of simulations that reflect students' real-life experiences (Johnson, 2002). In addition, teachers could also expand their classrooms by engaging students in projects that would take them outside the classroom into classroom-community based activities.

In the second of Johnson's categories, the *infused stand-alone classes*, the teacher infuses or inserts pertinent materials from other disciplines/subjects to work as examples to strengthen understanding of a topic (Johnson, 2002). This category is similar to the third category, the *linked subjects*. However, with linked subjects, separate subjects are united by overlapping materials and shared topics and are taught by teachers of the respective subjects. According to Johnson (2002), these teachers "confer to make certain that the material in one class complements and reinforces learning going on in another class" (p. 58), and thus, through overlapping projects and classroom assignments, students see how one subject connects with others in a meaningful way. In linked subjects similar topics such as 'fabrics dying' in biology, 'solution' in chemistry, and 'color and color combination' in physics could be combined in a manner that provides a rich context for the contextualized instruction (Johnson, 2002).

The fourth category, the *integrated course*, involves a single course created through a combination of two or more different subjects (Johnson, 2002). The course is usually team taught and consists of one set of objectives and assessments that covers the merged subjects. According to Johnson, an integrated course could, for example, involve a combination of biology, chemistry, and environmental science in addressing the issue of the dangers of chemical substances to the ecosystem and individual health. In addition, the class is linked with the community so as to support research on related students' projects. Thus, students are able to connect between the academic content and apply the knowledge in real-world situations (Johnson, 2002).

The sixth category involves *combining school and work*. In this type of contextualized learning, partnerships between classrooms and companies, service organizations, or other out-of-school learning settings are formed (Johnson, 2002). The approach, according to Johnson, not only gives students a real world incentive to master academic subjects, but also provides opportunities for students to grow personally. When handled well these partnerships "provide students with exciting and authentic opportunities to learn academic subjects by putting them into, or relate them with their immediate use in their contexts" (Johnson, 2002, p. 61).

The last category of contextualized learning in Johnson's (2002) classification is *service learning*. The primary aim of service learning is to gain specific academic knowledge while helping others in the community. According to Johnson, projects and assignments in service learning help students to relate to each other, to other people in the community, and to their contexts at large. They strengthen individual students and the whole community as they "blend the academic objectives [with] service goals" (p. 71). Johnson considered service learning as the most remarkable among all other methods, as "it alone, quite intentionally teaches that human beings are responsible for the well being of others and of the planet…it alone, gives young people hands-on opportunities to learn compassion as they learn chemistry" (p. 70). Service learning, therefore, works well with topics which connect with pertinent issues in the community such as water sanitation, pollution, soil chemistry, diseases etc (Johnson, 2002).

Finally, there Hull's classification (1995). Similar to Johnson's (2002) work, the classification by Hull (1995) relates more to instructional strategies than to the organization of a curriculum. However, the Hull's classifications focus more on cognitive strategies for achieving specific learning outcomes than on the kinds of classroom arrangements demonstrated by Johnson (2002). Hull's classifications, termed "forms of learning in context", include learning science through: relating, transferring, applying, experiencing, and cooperating (Hull, 1995, p. 32).

According to Hull (1995), contextualized learning through *relating* involves learning in the context of life experiences. The approach focuses on students' everyday sights, events, and conditions, and links these situations to new information to be learned or problems to be solved. Linkages between concepts learned in the classroom and students' life experiences are evoked through classroom activity, text, video, or a speech from the teacher, student, or guest speaker (Hull, 1995).

Closely related to *relating* is *transferring*. While in relating, the experience is brought to students for them to be able to see the link between the lesson and their everyday experiences (Hull, 1995), in transferring, the experience is brought to students for the purpose of "building new learning experiences on what the [learners] already know" (Hull, 1995, p. 61). Thus, in relating, the experience functions more or less as an example of what is being learned in class, whereas the experience in transferring serves to make a detailed connection between learners' prior knowledge and the new knowledge for a more meaningful learning experience.

In regard to *applying*, the ideas or concepts learned in school are applied in a useful context, which, according to Hull (1995), could often be "an imagined future or some other unfamiliar contexts" (p. 63). These contexts could first be brought to students through texts, videos, labs, or activities, and then followed by real-world experiences, such as study tours or mentoring arrangements.

In *experiencing,* though closely related to applying, learning tends to go much deeper than applying, whereby ideas and concepts are learned in the context of exploration, discovery, and invention (Hull, 1995). Instead of relying on passive contextual learning strategies such as videos, narratives, or text based activities, students are involved in a deep "manipulation of equipment and materials, and doing other forms of active research or projects" to further explore the ideas and concepts they learn in school (Hull, 1995, p. 66). They visit actual learning settings and participate in hands-on activities.

The last category in Hull's classification is learning in the context of *cooperating*. In this category, learning takes place through sharing, responding, and communicating with other learners. Students typically work with partners or groups through "delegating tasks to individuals, making observations, suggestions, and discussions" (p. 68). The technique is said to be suitable for contextual learning activities involving long, complex, and detailed procedures that necessitate distribution of activities across a group of learners (Hull, 1995).

In general, looking into the various views regarding the organization of contextualized science curricular experiences presented in this section, it is clear that Aikenhead's (1994) categorization relates directly with ways to organize the school science curriculum so the contexts from which learners draw their everyday experiences are taken into consideration. On the other hand, Johnson's (2002) perspectives relate more with classroom/instructional arrangements suitable for creating effective contextualized science curricular experiences. Yet, Hull (1995) perspectives are more of cognitive learning that may well support the learning of science in context. The eight categories of a contextualized science learning proposed by Aikenhead (1994) and later, reorganized and condensed by Kasanda et al. (2005) are organized into three types, namely: *context-infused*, *context-based,* and *context-focused* curricular experiences appear to be more feasible and practical, as, among other things, it has reduced the overlaps that seemed obvious in Aikenhead's (1994) classifications. In the end, while Johnson's classroom/instructional arrangements can be viewed as useful 'methods' by which to implement contextualized science learning, Hull's (1995) classifications could be seen as 'strategies', which, if used with Johnson's methods, would increase the effectiveness of the contextualized science learning experiences.

2.7 Some studies on context related science learning experiences and literature gap

A review of literature that draws on learners' everyday experiences shows that research in this area ranges from students' understanding and use of science concepts in their everyday life context (Avery, et al., 2011; Campbell, et al., 2000; Chu et al., 2012; Ramsden, 1997; Yang, 2007; Graham, 2011; Kasanda et al., 2005; Rivert et al., 2008) to students' and teachers' attitude, interest, and perceptions toward contextualized science curricular experiences (Verma, 2001; Raticliffe & Millar, 2009; King et al., 2008; Kim et al., 2012), to students' learning and engagement with science within contextualized teaching and learning environment (Bajracharya, 1995; Kelley, 2009; Del Rosario, 2009; Havu-Nuutinen, et al., 2009). A few studies also delve into factors that influence the use of environment/context in the teaching and learning of school science (Aldous, 2008; Koul, 1997; Osaki, 1995).

In their studies, Kim et al. (2012), Raticliffe and Millar (2009), King et al. (2008), and Verma and Habash (2005), explored ways context-based curricular experiences influenced students' motivation, attitudes, and interest toward science learning. They also examined students' perceptions towards this type of science learning. Although findings of their studies showed that students do like, and are enthusiastic about the approaches, and that these approaches positively affect their attitudes and interest towards science learning, none of the studies attempted to examine how students associated these curricular experiences with their success in science learning. Moreover, the studies did not attempt to find out if such students' response toward contextualized science curricular experiences might have in turn affected their teacher practices of science teaching.

On the other hand, studies which evaluated students' understanding and use of science concepts in their everyday context seemed to concentrate on the outcomes of implementation of the programs (Avery, et al., 2011; Campbell, et al., 2000; Chu et al., 2012; Ramsden, 1997; Yang, 2007; Kasanda et al., 2005). Little attention is paid to different ways programs are organized or implemented. In other words, the context or the situations that surround the implementation of the programs is not the major concern for the studies. Ramsden (1997), for instance, measured and compared the level of understanding of science concepts between students who studied science through context-based experiences and those who studied science through traditional approaches. Although her study found a significant difference in the level of understanding of science concepts between the two groups, she did not engage into identifying factors that might have contributed to the differences. Even though her study managed to spot the areas of difficulties that were encountered by both groups, she did not pay much attention to factors behind the success or failure of the contextualized curricular learning experiences in enhancing science learning as well as students' success in the subjects.

Likewise, Campbell et al. (2000) and Kasanda et al. (2005) investigated students' ability to use out-of-school everyday contexts in science classrooms. This use of contexts was portrayed against the backdrop of educational philosophy of learner-centred teaching such that, they also examined the pedagogical strategies that accompanied the use of context in science teaching and learning. Their study findings demonstrated students' improvement in the use of science ideas and concepts in their everyday context, after they have learned science through context-based approaches. Nonetheless, in spite of these improvements, their study did not attempt to examine from the point of view of students, whether this ability to use science ideas or concepts in everyday life context would have any impact on their academic success in science. Moreover, although 'pedagogical practices' was one of the aspects in their investigation, they seemed to have been concerned only with strategies that were applied in teaching science through context within classrooms. None of them gave a thought about the fact that students' success in learning science through this way, might have in-turn affected their teachers' perceptions and practices of school science teaching.

Some studies also delved specifically into students' learning and engagement with science. These studies focused on how students participated in science learning as individuals or groups within the contextualized teaching and learning environment (Kelley, 2009; Del Rosarion, 2009; Yang, 2007; Havu-Nuutinen & Keinone, 2009). Although findings of these studies showed that through contextualized science learning experiences, students improved their thinking, engagement and learning, in some cases, the studies revealed some reluctance and/or resistance towards the approaches as observed in Kelley and Del Rosario studies. The fact that students were not given chance to participate in identifying relevant areas that might have been interesting in exploring science within their context, or involved in planning and organizing contextualized learning experiences that they participated in, made them feel that they were experiencing 'everyday experiences' that were not consistent with what they were actually experiencing in their everyday lives (Del Rosario, 2009). Nonetheless, none of the reviewed studies attempted to involve students in identifying, planning or organizing the contextual learning experiences and see how this involvement would in turn affect the way in which the students engaged with, and participated in science learning.

The present study attempted to fill in the gaps identified in this chapter. While involving students in the entire process of identifying, organizing and implementing the contextualized science curricular experiences, the study explored how students experienced this way of science learning, and consequently, how their success in learning science through this way affected their teacher practices of high school science teaching. Alongside, the study also explored factors in the current high school science teaching in Tanzania that might be hindering or preventing teachers from employing and utilizing contextually based mediations in their everyday science teaching.

Chapter 3: Methodology

The present study aimed to investigate the effect of contextualized science curricular experiences on students' learning and their teachers' teaching in a Tanzanian context. More specifically, the study aimed to observe, analyze, and interpret students' and teachers' views/perceptions towards contextualized science curricular experiences, in order to find out how these experiences influenced students' learning, which in turn, affected their teachers' practices of high school science teaching. Inquiry into this research, then, was guided by three sub-research questions namely: *1. How do high school students experience science learning in a science unit that integrates both classroom and out-of-classroom real life science learning activities? 2. How does students' success in this way of science learning in Tanzania affect their teachers' teaching? 3. What factors in the current high school teaching and learning in Tanzania, prevent teachers from employing and utilizing contextually based mediations in the teaching and learning of the school science, and how these could better be addressed?*

In this chapter, I present the research design for the study including the activities involved, a description of the study location and participants, and a detailed account of the data collection and analysis methods. I then illuminate issues related to the study's validity and credibility as well as ethical considerations.

3.1 Research design

Research in this study was governed by phenomenographic and ethnographic principles within an interpretive case (LeCompte & Schensul, 2010; Martin et al., 1992; Marton, 1986; Merriam, 1998; Svensson, 1999; Walker, 1998), and employed a mixed method design (the quantitative questionnaire and the qualitative interviews) in data collection and analysis (Creswell, 2014; Johnson & Onwuegbuzie, 2004).

As elsewhere stated in the literature, case study design is commended for the ability to capture details of the individuals, group, and/or phenomena relevant to the purpose of the study and within a real-life context of the participants (Creswell, 2014; Stake, 1995; Yin, 2017). It is described as the most flexible of all research designs, allowing the researcher to retain the holistic characteristics of real-life events while at the same time investigating the empirical events (Yin, 2017). The defining feature of a case study research is the focus on 'how' and 'why' questions (Myers, 2002). For this reason, case study is appropriate for the descriptive and exploratory studies (Mouton, 2001).

While answering the questions of how and why, an interpretive case study then, allows an understanding of the world from the subjective point of view of the participants, rather than the objective observer, as it is more concerned with actuality and relevance, rather than rigor (Leitch, Hill, and Harrison, 2010). The present study chose to use an interpretive case because the study aimed to examine the meanings students and teachers attached to their actual experiences of the phenomenon under investigation; that is, their perceptions of the effect of contextualized science curricular experiences on their own learning and teaching.

The use of phenomenographic and ethnographic research principles within the interpretive case, takes advantage of the two methodologies to allow an in-depth exploration of the phenomenon under investigation in an extended period of time while examining the relationship between the people and the phenomenon from the point of view of their experiences. The approach combined both naturalism and constructionism which allowed the researcher to become close to the subjects and capitalize on their familiarity with, and their involvement or participation in creating and being created by the phenomenon being investigated (c.f. Katz & Csordas, 2003; Patton, 2002). Eventually, the ethnographic element illuminated the participants' feelings and opinions and provided more information about their everyday experiences, whereas, the phenomenographic element went beyond to deal with the meanings participants attached to their words/or experiences, through their views and/or perceptions.

Initiated by Marton (1986), phenomenography is a qualitative research theoretical framework designed to answer questions related to how people think and perceive the world or phenomena around them. According to Martin et al. (1992), phenomenography is a qualitative research methodology within interpretivist paradigm which entails qualitative investigation of the different ways people experience, conceptualize, and understand various aspects of phenomena around them. Walker (1998) posits that the approach is focused on ways of experiencing different phenomena, ways of seeing them, knowing them, and having skills about them. Unlike phenomenology, which describes what the world/phenomena looks like without learning how to see it (Walker, 1998), in what Bernard et al. (1999) termed as first order perspective which describes the world as 'it is', phenomenography is interested in second order perspective which focuses on describing the world 'as it is seen' (Bernard et al., 1999).

Researchers employing phenomenographic approaches therefore, choose to learn how people experience a given phenomenon and not to study the phenomenon itself (Martin et al., 1992). The conceptions of the researcher about the phenomenon are not the focus of the study; rather, the focus is the conceptions people have of the phenomenon (Dortins, 2001; Svessons, 1997). Thus, researchers strive to be neutral to the ideas of the study participants, and as an empirical study, they do not study their own awareness and reflection, rather, the awareness and reflection of the subjects or participants (Orgill, 2002). Findings of the research in this case, are allowed to emerge rather than be imposed (Morgan, 1997; Newman, 2000), and the key feature is ‘bracketing’ (Dortins, 2002; Orgill, 2002; Svesson, 1997; Tufford & Newman, 2012), where the researcher identifies and sets aside personal experiences with the phenomenon under study and focuses on experiences and meanings that the researched attach to the phenomenon being investigated (Also, Denzin & Lincoln, 2008; Groenewald, 2004).

On the other hand, ethnography entails to engage in peoples’ lives in an extended period of time, with the intension to observe what is happening, listen what people say and do, and collect whatever data available to throw light on the issue with which the researcher is concerned (Agar, 1986; Atkinson, et al., 2007; Hamersley & Atkinson, 2007; LeCompte & Schesul, 2010). Research in this case, focuses on describing and interpreting the shared and learned patterns of values, behaviors/actions, and beliefs displayed by the participants, and the method involves extended participant observations where the researcher is immersed in the day to day lives of the people involved while observing and interviewing groups of participants (Harris, 1968; Patton, 2002; Schensul & LeCompte, 2016).

Weaving interpretive approaches throughout, the present study focused on describing and interpreting what students and teachers said and/or did, as they participated in science lessons that integrated both classroom and out-of-classroom real-life learning environments. Since interpretive approaches are said to be powerful for understanding the subjective experiences of the people as well as beneficial to gaining insights into people’s motivation for their actions (Atkinson, 2007; Denzin & Lincoln, 2003; Creswell, 2014; Erickson, 2011, 2012; Gubrium & Holstein, 2003), the study took the form of and was characterized by: a close interaction between the researcher, the subjects, and the phenomena of interest; attempt to gain an in-depth understanding of what was happening in real time and real context in order to link it with what the subjects (students and teachers) said during the interviews; and, a continuous development of ideas and understandings emergent through evidence from what was said and done. Eventually, interpretations were shaped by the study focus as well as the the researchers' vivid experiences gained through participant observation (Grbich, 2013; LeCopmte & Schensul, 2010; Patton, 2002) and guided primarily by the theoretical framework that drew upon the sociocultural and contextual learning theories (Daniels, 2001; Hull, 1993, 1995; Karweit, 1993; Vygotsky, 1978, 1987), and partly by the expectancy value theory of achievement motivation which informed the way in which students responded to the learning approach that the study was implementing (Wigfield & Eccles, 2000; Wigfield & Cambria, 2010).

The mixed method research strategy within the case (Creswell, 2014; Gable, 1994; Morgan, 2007; Yin, 2017) allowed the researcher to use a variety of data sources to arrive at a better understanding, as well as ensure clarity and insight into the phenomenon under investigation. Mixed-methods research combines both the quantitative and qualitative research approaches in a single study (Creswell, 2009), and according to Creswell and Plano-Clark (2007), the approach is more than "simply collecting and analyzing both kinds of data...It involves the use of both approaches in tandem so that the overall strength of a study is greater than either the qualitative or the quantitative research" (cited in Creswell, 2009, p. 4). Because of the eclectic nature, mixed methods permits the researcher to move from one methodological approach to another. Embedding mixed-method research approach within this phenomenographic-ethnographic case study allowed the researcher to choose from a range of available strategies and techniques when delving into students and teachers' views/perceptions towards contextualized science learning. The use of mixed methods helped corroborate students' perceptions obtained through the questionnaire, with their views obtained through qualitative interviews (focus group discussion interviews) as well as informal conversations/interviews conducted throughout the period of the study. A mixed methods approach also helped clarify contradictions that arose between and among these results during data collection and analysis (Creswell, 2014; Johnson & Onwuegbuzie, 2004; Onwuegbuzie et al. (2010). Ultimately, following phenomenographic and ethnographic principles throughout the study helped the researcher to carefully trace how students and teachers constructed and reconstructed reality over a period of time from the point of view of their actual experiences (Denzin & Lincoln, 2003; Dortins, 2002; LeCompte & Schensul, 2010; Martins et al., 1992; Patton, 2002) by following their views/perceptions and practices as they participated in science learning that combined both classroom and out of classroom real life learning activities.

Thus, in summary, the study involved six science teachers and 180 students. Data collection took place through stages as summarized in Figure 1. The research began by introducing the study (the idea of contextualized science learning) to both teachers and students, followed by all students filling out the pre-experience questionnaire, and a few students (12 students) chosen to participate in pre-experience focus group discussion interviews. This data aimed to gain insights into students' views/perceptions prior to implementation of the study and was used to modify and improve the organization of the study prior to implementation. The next stage was study implementation, which involved several rounds of in-class activities and out-of classroom real life learning activities for 8 months. During this time, several observations and informal interviews with both individual students and teachers were conducted and the data recorded as researcher's field notes. This data informed the ongoing changing views or perceptions towards contextualized science learning as both teachers and students participated in the study, and was used later to support the post experience data from questionnaire and focus group discussion interviews. Towards the end of the study (i.e. after the eight months of the project), all participating students filled out the post experience questionnaire, with a group of 12 students chosen to participate in post-experience focus group discussion interviews. A post-experience focus group discussion interview was also conducted with all participating teachers in order to gather their views or perceptions towards the learning approach that the study was investigation. Eventually, data from students was used to respond to the first research question for the study, whereas data from teachers was used to respond to the second and third research questions for the study.

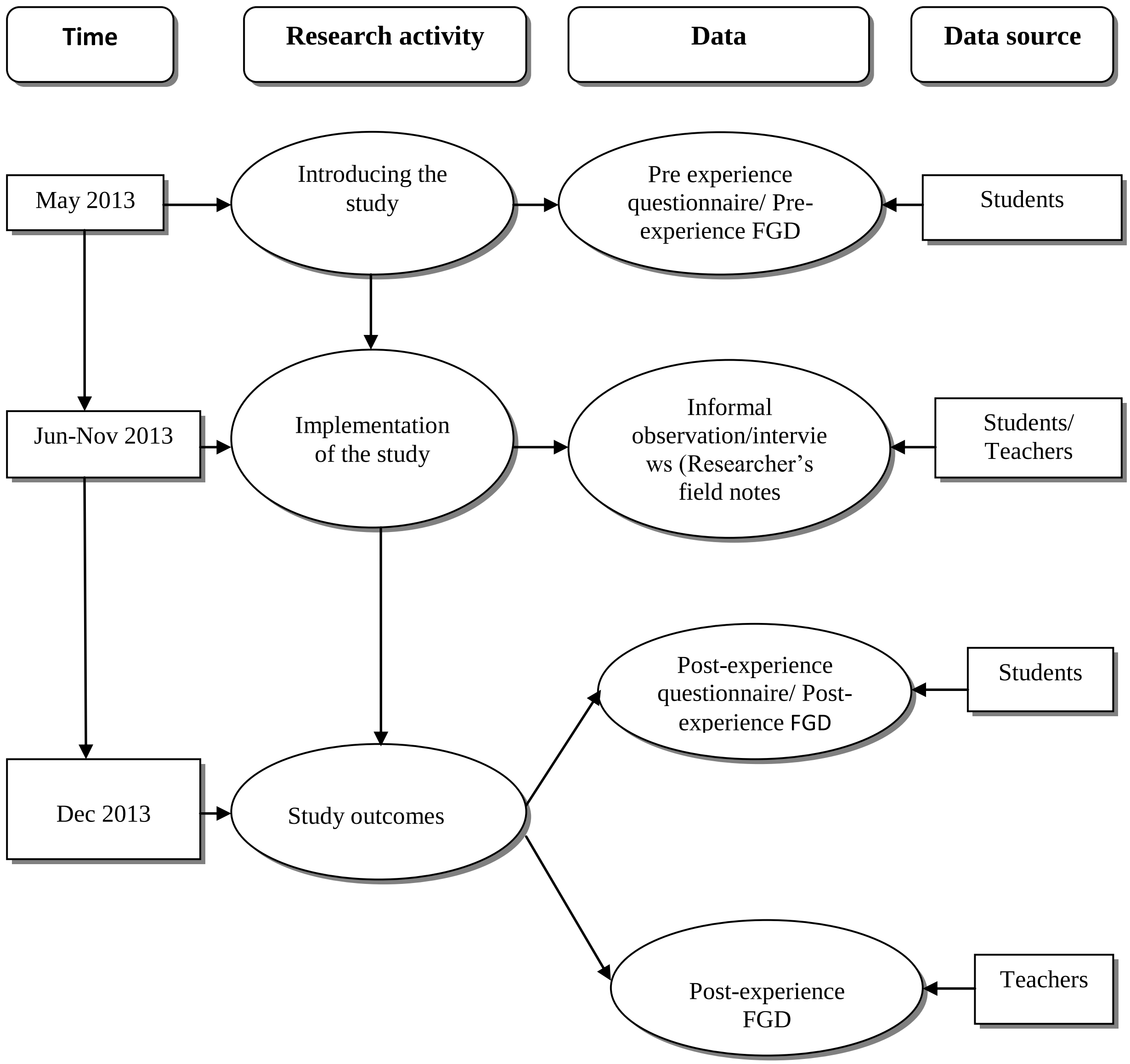


Figure 1: Research design timeline

3.1.1 Details of research design and activities: the study

This phenomenographic-ethnographic case study aimed to explore how the link between the school science and activities taking place within learners' everyday local environment can influence students' learning and their teachers' teaching, in a Tanzanian context. To arrive at this objective, the study was organized such that learning involved linking the school science with the activities done by "*Wajasiriamali*" manufacturing and processing groups. Students had the opportunity to explore, learn, and appreciate the application of various science ideas and/or concepts that they learned in school through direct interaction with *Wajasiriamali* artisans, their products, production, and processing activities, as well as explore how these activities in turn informed the science that they learned at school.

In general, *Wajasiriamali* groups comprise not less than five individuals/members (the number could raise up to tenths), usually gathered together in homes, or under the sheds down the streets, or in locally established locations, and are engaged with manufacturing and processing of various products, with their activities embodying a diversity of applied science, from which students could investigate various ideas and concept that they learn in the school science.

Figure 2: *Wajasiriamali* site down the street: Students exploring charcoal stove making

Typical activities performed by these groups include: 1) Activities related to fabrication of metal products such as brightly painted buckets and boxes, kerosene lamps, cooking pots and utensils, charcoal stoves, chicken brooders etc; 2) Small scale manufacturing of chemical related products such as loundry and detergent soaps, air freshener, stain remover, ink manufacture, chalk making, lather dyeing, dyeing of clothes etc; and 3) Small scale food processing and packaging (mostly done by women groups) such as processing of wine/juice from fruits, and processing and packaging of such products as jam, butter, mango pickle, soya drink, ground nuts, honey, cooking oil, spices etc.

Figure 3: *Wajasiriamali* site in the backyard: Students exploring powder soap making

Embodied in these activities is a variety of applied sciences such as thermodynamics, chemical transformation and reactions, chemical and processing, applied nutrition and so on. The present study was organized around visiting these *Wajasiriamali* production and processing groups (the selected sites) for exploration and learning, followed by classroom sessions characterized by group activities, group presentations, and general classroom discussions. Research and learning was therefore organized into the following stages or cycles:

1. *Pre Wajasiriamali study visit activities and interviews*

The study began by the researcher holding a workshop with selected science teachers (six teachers) from the selected case study secondary school with the intension to seek their views regarding current discourses about science curriculum in Tanzania, as well as discuss with them the idea of contextualization of science curriculum and instruction in the Tanzanian context.

This discussion resulted into identification of topics, themes, ideas, and/or concepts in the mandated science curriculum, that teachers recognize and /or consider to explain phenomena embedded in students' local/everyday life environments, and in this case, related to activities done by *Wajasiriamali* artisans. Also, the discussion involved identification of locally based phenomena, particularly drawn from activities done by *Wajasiriamali* groups, that teachers consider to explain or illustrate science concepts prescribed in the Tanzanian high school science curriculum.

Students from the participating teachers' classrooms (about 90 students from each of the 2-form four science streams) were also involved in this study. At this initial stage, they participated in class discussion about contextual science learning (guided by the researcher and participating teachers), as well as filling out the pre-experience questionnaires, which both of these activities aimed to elicit their perspectives regarding contextualization of science curriculum and instruction and to help arouse their interest and motivation to learn science through the approach. A pre-experience focus group discussion interveiew with selected students was also conducted at this stage, and together with the pre-experience questionnaire responses, helped the researcher to learn in-depth, the students' initial views/perceptions towards contextualized science learning.

Having gathered the initial information, the researcher together with the participating teachers conducted a visit to the selected *Wajasiriamali* manufacturing and processing sites in order to actually identify the activities, products, and processes that could be linked with the identified topics/concepts in the Tanzanian mandated high school science curriculum. The visit also involved arrangements and negotiation with the *Wajasiriamali* artisans on the formal study visit by the students. Then, a second workshop was held by the researcher and teachers for the purpose of developing contextualized learning units/lessons in chemistry, biology, and physics ready for the implementation of the study (see Appendix I).

2. *The Wajasiriamali study visit*

The developed contextualized science lessons were then implemented by the selected teachers in collaboration with the researcher. Implementation took the form of collaborative teaching, marked by study visits to the selected *Wajasiriamali* sites, followed by in-class group activities, discussions, and presentations. During the visits, students engaged with exploration and learning for about two to three hours by visiting several sites/stations as time allowed. Throughout the visit, students were involved in conversations with various artisans, seeking information about their products, production, and/or processing activities through asking questions in search of clarification and insights, as well as being asked by the *Wajasiriamali* (see Appendix II). They also had the opportunity to ask themselves and reflect upon the way these activities related to the science that they learnt at school.

3. *Post Wajasiriamali visit in-class activities*

After each study visit, a post *Wajasiriamali* visit in-class activity was conducted, that required students to work in their respective *Wajasiriamali* visit groups in order to discuss their visit experiences, and this activity was guided by questions developed by the researcher in collaboration with the participating teachers (see Appendix III). Completion of the task, was marked by students selecting two to three production and/ or processing activities done by *Wajasiriamali* they found most interesting and from which they learnt the most, and prepared a classroom presentation (of about 10-15 minutes) on how they understood the processes, including how these products could be improved. The lesson was concluded by a 10-15minutes plenary session that involed whole class discussion and reflection, including attempt to illuminate mutual relationships between the school science and *Wajasiriamali* production and processing activities that students observed/discovered during the visits.

These learning cycles two and three repeated bi-weekly during the period of eight months of the implementation of the study, based on the participating teachers arrangements and the convenience of the school timetable.

4. *Post experience interviews and questionnaire response*

Towards the end of the project (during the 8th month), having gone through several rounds of science lessons framed around *Wajasiriamali*-school science learning cycles, students completed the post-experience questionnaires as well as participated in focus group discussion interviews. This was to seek their post-experience views or perceptions towards this approach to science learning, and particularly, their feelings/opinions/or thoughts about how the approach impacted/would impact on their own learning and achievement in science. Similarly, all six participating teachers participated in a focus group discussion interview that entailed examining how students contextualized learning experiences, impacted on the way they perceived science teaching and learning, and particularly, how they thought their day to day practices of high school science teaching was changed/transformed as a result of their engagement with this approach to school science learning.

3.2 Study site and participants

In describing the context of the case study, Creswell (1998) observes that the researcher may situate the case within a ‘physical’, ‘social’, ‘historical’, and /or ‘economic setting’ for a particular case (p. 61). Moreover, according to Creswell (1998), the focus may be on the case itself, where, because of its uniqueness, requires a study – an *intrinsic case study*, or, where the case is used instrumentally to illustrate the issue – an *instrumental case study*. As noted in the previous section, the present study’s ‘case’ was used as an ‘instrumental case’ to host and illustrate the participants experiences of the phenomenon that the study was investigating (Creswell, 1998; Yin, 2009).

Thus, the study was conducted in a high school located in the outskirts of the main and the largest commercial city of Tanzania, Dar es Salaam, where most of *Wajasiriamali* groups in the city are located. This is a ‘day’ school (as opposed to boarding/residential school) where all students attend school from their homes. Because of the nature of the area, students do not travel long distances before they meet a variety of *Wajasiriamali* groups where they can freely explore and learn. Some students might also come from families or connected with individuals involved in or with *Wajasiriamali* production activities. Thus, the choice of this study’s ‘case’ was both convenient and strategic to inform the real life connections between the school science and learners’ everyday life experiences (Luborsky & Rubinstein, 1995; Robinson, 2014; Palinkas et al., 2015). Consequently, the study turned out to be exciting, especially when students realized that connections exist between the school science and these local entrepreneurship activities around their areas, and they could learn from them, as well as share the knowledge they learn in school. Situating this project in this area enabled the students to see the relevance of the project/study and allowed them to fully engage with it.

In fact, it is argued elsewhere in the literature, when the academic knowledge is socially and culturally situated within the lived experiences of the learners, there is a high level of interest and appeal, the learning is easier, and the possibility that learners will succeed academically increases because they learn through their cultural and experiential filters (Au & Kawakami, 1994; Gay, 2000; Hollins & Oliver, 1999; Nashon & Anderson, 2013). Furthermore, according to contextual learning theory, learners will effectively engage in learning if their minds are able to see meaning in context, that is, in relation to their everyday life environment (Hull, 1995; Johnson, 2002). The study aimed to make science learning relevant and meaningful by exploring useful connections between the school science and the activities taking place within the surroundings of the learners. Choosing a school in close proximity to *Wajasiriamali* production activities, the focal point of the present investigation, increased plausibility of the study and made it more relevant and meaningful to the learners as well as the teachers, and more importantly, helped make data collection process easier and more accessible.

Figure 4: The map of Tanzania

The study involved approximately 180 students (Two Form 4/grade12 streams of about 90 students each), usually aged between 15 and 18. Initially, Form 3 class/ grade 11 was purposively chosen because by the nature of high school science curriculum in Tanzania, this is the level where students require a deeper understanding of science concepts in readiness for the Form 4 exit National Examination in the following year (c.f. Nashon & Anderson, 2013). While this is an important examination in the sense students need high pass marks to be selected to join science related combinations in A-level, which will lead to joining lucrative professional degrees such as engineering and medicine at university, Form 4 is also a stage where, unfortunately, nearly half of students will stop their formal education to find their way to informal sector including joining or forming the *Wajasiriamali* artisanal groups in effort to earn living. However, having being introduced to the study by the researcher, it was requested by the school leadership, that the study be conducted with Form 4 students instead of Form 3, given the anticipated benefits/advantages they believed these students would gain from the project. Since logically, same reasons for choosing Form 3 sample applied equally to Form 4, the school request was supported and Form 4 class was chosen to participate in the study. In fact, conducting this study with Form 4 students was perceived beneficial not only because it would help them learn science and perhaps and pass their exams, but also because the study would act as a way of transitioning them to the world of work through the project's real world experiences which linked the school science with *Wajasiriamali*, the sector which they were going to be part of, directly after finishing their national examinations.

3.3 Data collection methods

The present study adopted pragmatic epistemological stance in data collection and analysis, where both quantitative and qualitative data were collected and analyzed for in-depth understanding of the participants' views/perceptions towards the phenomena being investigated (Creswell, 2009; Johnson & Onwuegbuzie, 2004; Patton, 2002). In addition to the intension to gain thorough understanding of the research problem, the use of both quantitative and qualitative data collection techniques was important in increasing credibility or trustworthiness of the research results (Creswell, 2014; Johnson & Onwuegbuzie, 2004; Lincoln, Lynham, & Guba, 2011). Creswell (2014) points out that, researchers employ multiple data sources to examine evidence from these sources for the purpose of building coherent justification of the emergent themes. When the themes are established based on convergence of several sources of data or perspectives from participants (triangulation), the process is said to add to the validity and credibility of the study (Bryman, 2006; Creswell, 2014; Greene, et al. 1989; Onwuegbuzie & Combs, 2010). This study employed quantitative questionnaire, qualitative interviews (focus group discussion interviews), and researcher's field notes, collected primarily from the informal conversations with participating students and teachers, all with an intension to corroborate the data to ensure overall strength of evidence with regard to the issue under study.

Since the present study was introducing a new science learning innovation, both questionnaires and focus group discussion interviews were administered twice, before and after the implementation of the study to articulate students' perceptual experiences due to the learning approach the study espoused. Besides, administration of the questionnaire, and particularly the pre-experience questionnaire, played a key role in introducing the innovation to the students, building awareness, stimulating their thoughts, and to pique their curiosity and interest to learn science through this approach (c.f. Nashon & Anderson, 2013). In researching learning experiences, Hitchcock (2006) cocludes it is a worthwhile endeavor to explore participants' perceptions about a learning phenomenon being researched, prior to and after implementation of the program, if a comprehensive understanding of the participants' perceptual experiences is to be established. It was, thus, appropriate to introduce the science learning approach that the study was implementing, through the pre-experience questionnaire, not only because of the need to collect initial views/perceptions towards contextualized science learning but also to ensure awareness about this approach to science learning was clear to all participating students, so they would be able to appropriately discern their experience about the approach. The post-experience questionnaire and focus group discussion interviews were administered after the implementation of program to help articulate the influence of this pedagogical approach in the teaching and learning of the school science, in a sound and justifiable manner.

3.3.1 Questionnaire

A modified Instrument for Assessing Disposition for Contextual Learning of Science – I-ADCLOS questionnaire (Nashon & Madera, 2013; Nashon, Ooko, & Kelonye, 2012) was used to examine students' perceptions towards contextualized science learning (see Appendix IV). This was administered to all participating students (approximately 180 students) from the selected case study secondary school, and as noted earlier, prior to and after the implementation of the study. Whereas the original validated I-ADCLOS instrument had 31 items, categorized into three sub-scales, related to attitudes toward contextual learning of science, personal awareness of influences on learning of science, and orientation towards collateral learning, the modified I-ADCLOS used in the present study had 18 uncategorized items. Since the main aim was to work at the individual item level (in order to learn how students rated various aspects of this type of learning), rather than the questionnaire level (Stanton et al., 2002; Franke, Rapp, & Andzulis, 2013), I chose to include only those items that measured or assessed particularly, student perceptions towards this approach to science learning, and these were checked for reliability as will be seen later in data analysis chapter (Franke, Rapp & Andzulis, 2013).

Because I-ADCLOS was a Likert type scale, each item in the scale was assessed for wording before the beginning of the analysis. All items stated negatively were reverse coded before they were entered in SPSS program for data analysis. The scale levels were strongly agree, agree, undecided/neutral, disagree, and strongly disagree, and were coded 5, 4, 3, 2, 1 respectively and reverse coded accordingly during data entry. There was no sampling in filling out the questionnaires as all participating students were involved in this exercise.

3.3.2 Focus group discussion interview

As mentioned earlier, in order to delve deeper in to exploring students' views/perceptions, a focus group discussion interview (FGD) was conducted with select groups of students (see Appendix V). This was to be corroborated further with the questionnaire results for an in-depth understanding of the students' views/perceptions towards the learning approach that the study was investigating (Greene, et al. 1989; Onwuegbuzie et al., 2010). According to Yin (2011), FGD entail interviewing a group of persons for a short time, say one hour, with an intention to follow certain set of questions derived from the case study protocol in order to corroborate certain information that the researcher may have already established. FGD interviews in this study was thus intended to explore in-depth what students had to say regarding the type of science learning the present study was espousing, having surveyed their initial views/perceptions through questionnaire technique.

Literature shows that FGD interviews is the best way to gather people from similar background and experiences to discuss a particular topic of interest (Krueger & Casey, 2014; Morgan, 1997; Stewart & Shamdasani, 2014; Wong, 2008). According to Morgan (1997), the strength of FGD relies on the fact that it allows the participants to agree or disagree with each other so that the researcher gains insights into how a group of participants thinks about an issue. In addition, FGD reveals to the researcher a range of opinions or ideas held by participants about the issue, as well as detect inconsistencies and variations in terms of their beliefs, experiences and practices (Stewart & Shamdasani, 2014). Moreover, Kueger and Casey (2014) observe that FGD can also be used to explore the meanings of survey findings that cannot be explained statistically and thereby increase the strength of the research evidence.

Therefore, because FGD involves an in-depth exploration of the issue under investigation through a small group discussion (Stewart & Shamdasani, 2014), two groups of students were purposefully selected from the two participating science classes for the FGD sessions. The selection criteria involved among other things, willingness to participate and ability to communicate experiences and opinions in an articulate, expressive, and reflective manner (Bernad, 2002; Creswell & Plano Clark, 2011; Etikan et al, 2016; Palinkas et al., 2015; Patton, 2002). Following the suggestions proposed by Smith et al. (2009), six students were selected from each class, summing up to 12 students in the entire focus group discussion interview. According to Smith et al. (2009), a focus group discussion interview needs to involve sufficiently small group of individuals so that each of the participant have a locatable voice within the study. As such, they suggest three to16 participants for a single study, with the lower end of the spectrum suggested for undergraduate projects and the upper end for large scale funded projects (c.f. Palinkas et al., 2015). Plus the criteria mentioned above, the participating teachers suggested that the focus groups involve both high and average performing students for a better spread of the results, and particularly, gaining the perspectives about this type of science learning from varied student abilities. This was found logical and reasonable, and hence, adopted when selecting students for the FGD interviews. Different students were selected for the pre- and post-experience FGD interviews. All six participating teachers were also involved in the FGD interviews that entailed to examine their views about their experience with contextualized science learning, as well as examining the reasons for the non-use of this approach in their day-to-day science teaching (see Appendix VI).

3.3.3 Researcher's field notes

One of the purposes of being in a research setting is to permit a researcher to experience that setting or situation (Patton, 2002). In that case, formal or informal field notes become the best way in which to record events, behavior or situations in real context and real time, and these may either form the major part of the research data corpus, or be used to supplement, complement, or substantiate the main data obtained through other methods of data collection (Denzin & Lincoln, 2008; Erickson, 2011; LeCompte & Schensul, 2010).

According to Patton (2002), field notes involve "descriptions of what is being experienced and observed, quotations from the people observed, the observers feelings and reaction to what is observed, and field generated insights and interpretations" (p. 305). As such, they are approached with a disciplined intension not to impose preconceptions or early judgment lest not interfere or lend into premature, false, or biased interpretation of the results (Patton, 2002; Yin, 2009).

Thus, in addition to focus group discussion interviews, as a participant observer in the field, I also engaged with occasional informal conversations with students, that took place in- and outside classrooms, most of which came up out of students' curiosity about this approach to science learning. Those, which appeared to be relevant in informing how students viewed the approach, were recorded as researcher's field notes and incorporated as part of data corpus, and in this case, in the form of quotations. Schensul et al. (1999) posit that in exploratory qualitative research, and particularly ethnographic research, data collection can occur through formal or informal conversations or interviews throughout the course of the study anytime a domain, concept, or idea calls for further investigation or clarification. I made use of the random informal conversations and student questions during the course of the study, to clarify, ask further, and learn more about their views/perceptions, and these were recorded as part of my field notes (Patton, 2002), and used to support/complement the data collected through the focus group discussion interviews (LeCompte & Schensul, 2010; Patton, 2002; Yin, 2009).

3.4 Data analysis methods

The process of data analysis involved subjecting the pre-and post-experience questionnaire responses into descriptive statistics to examine students' views/perceptions towards contextualized science learning prior to and after the implementation of the study. Then, the questionnaire was further subjected to exploratory factor analysis and confirmatory factor analysis (for the post-experience data), which were meant to determine factors that underlay students' views/perceptions towards this approach to science learning, prior to and after the implementation of the study. These factors, named as perceptual dimensions, were then used as codes to guide the analysis of the pre- and post- experience focus group discussion interviews respectively, and this was done by way of searching for manifestation of the perceptual dimensions across the interview responses.

On the other hand, the focus group discussion interviews with teachers were analyzed through thematic analysis, a rigorous process which involved several rounds of listening to the video clips, review of transcripts for the data sets, identification of excerpts from the data sets, as well as comparing and contrasting of the emergent themes. Additionally, excerpts/ quotations from researchers' field notes were also extracted and used to complement/ support the data from the focus group discussion interviews.

3.5 Validity and credibility issues

Various scholars have stated what it takes for a researcher to maintain validity and credibility of his or her research study. Among the frequently mentioned aspects include: the time spent in the field; rigor of the methods and procedures; sufficiency and accuracy of findings, analysis, and interpretations; truthful, plausibility, and credibility of the accounts; relevance of the accounts i.e. whether the accounts are important and contribute to the field, previous findings, methods, theory, or social policy, and so on (Creswell, 2009; Creswell & Miller, 2000; Erickson, 2012; Hammersley, 1998; Patton, 2002). Particularly with qualitative research, validity and credibility issues, also focus on whether or not findings of the research are accurate from the stand point of the researcher, the participants, or the readers of the account (Creswell, 2014; Gibbs, 2007; Grbich, 2016; Lincoln, Lynham, & Guba, 2011).

Several issues were observed in the present study in order to arrive at credible results. The study was conducted over a period of eight months, which was sufficient to allow for prolonged and consistent follow-up of similar phenomena and settings so that the researcher was able to identify, assess, and record salient features, factors, and typical happenings (Hammersley, 1998; Lincoln & Guba, 1985). Furthermore, as noted earlier, data was collected from various sources including repeated administration of questionnaire, focus group discussion interviews, as well as informal conversations that occurred throughout the period of the study. This data was corroborated during analysis and interpretation, in order to further the strength of evidence with regard to the study (Creswell, 2014; Lincoln, Lynham, & Guba, 2011; Morgan, 2007). Furthermore, the focus group discussion interviews were conducted by the researcher himself, and audio and video recorded in order to ensure integrity and accuracy during analysis and interpretation of the results (Krueger & Casey, 2014; Miles & Huberman, 1994; Rabiee, 2004). In addition to that, transcription was done verbatim, and quotations taken as uttered by the interviewees with minimum modification for the better understanding.

Creswell (2014) identify several strategies that a researcher might adopt in order to increase accuracy of his/her research findings, as well as convince readers of that accuracy. Among the strategies include: *triangulation* – which involves examining evidence from different sources; use of *member checking* – by taking the report or specific descriptions back to participants; spend *prolonged time* in the field; using *peer debriefing* to enhance accuracy of the accounts; and the use of *external editor* to review the entire project (c.f. Lincoln, Lynham, & Guba, 2011; Patton, 2002; Yin, 2017). I used member checking, where two participating teachers and two participating students read the respective interview transcripts and selected quotations that were incorporated in the analysis, and they had the opportunity to correct or propose corrections or deletions where they believed descriptions were unclear, irrelevant, or inconsistent with what they believed they knew. Numerous quotations were then used to report students' and teachers' views of their experiences, and alternative explanations provided for readers' judgment of evidence and its interpretation (Grbich, 2016; Lieblich et al., 1998; Patton, 2002). I also involved peer debriefing, where a colleague student agreed to read the analysis and ask questions that aimed to ensure that the account resonated with the research participants and the people in general, rather than the researcher himself. Finally, I demonstrated relevance of the findings by showing how they were important to the target community, how consistent they were or were not with the previous findings; and eventually, what contribution they brought to the field of science education and learning.

3.6 Ethical considerations

The present research involved collecting data from people about people and the phenomena they were experiencing (Creswell, 2014; Panter & Sterba, 2011; Patton, 2002; Punch, 2005). Because of that, Creswell (2014) states that it is the duty of the researcher to protect their research participants, develop trust with them, promote the integrity of the research, guard themselves against misconduct and impropriety that might reflect on their organizations or institutions, and cope with new challenging problems. Stated elsewhere in the literature, ethical questions range from and relate to such issues as personal privacy and disclosure, vulnerable subjects, sensitive topics, participants' rights and benefits, authenticity and credibility of research data and report, respect of institutions/organizations, power imbalances, plagiarism, and many others (Creswell, 2014; Hesse-Biber & Leavy, 2011; Israel & Hay, 2006; LeCompte & Schensul, 2010; Patton, 2002; Sarantakos, 2005).

Throughout the study, I ensured participants' right to privacy was maintained, data collection authorization obtained, and ethical guidelines followed. A statement was made to the participants to assure them of their rights to refuse to participate or withdraw at any point during the research process without consequence to themselves or their parents or guardians (for students). I also ensured that I fully explained to the participants, in appropriate clear language, all basic information about the study and the task ahead, and made sure they all became aware of the nature of the study and agreed to participate without any persuasion on the part of the researcher (LeCompte & Schensul, 2010). As noted in the previous sections, awareness of and about the study was raised through holding introductory meetings with participating teachers as well as plenary discussion sessions with students, during which various questions were raised and clarified.

Both teacher and student participants were informed of ways their anonymity and confidentiality would be maintained. While participating students signed assent forms, teachers and parents or guardians signed consent forms. All participants were given opportunity to review the forms, and were made to feel free to sign or reject them. To secure confidentiality, all assent and consent forms were identified by codes and/ or pseudonyms instead of participants' names. This also applied to the interview transcripts, questionnaires, and researcher's field notes that were collected from specific individuals. Eventually, the essence was to ensure that throughout the project, the need to carry out the study was never above the responsibility to maintain the well being of the participants, and no harm was caused, either physically, mentally, or socially, due to participation in this research (Gay et al., 2012; LeCompte & Schensul, 2010; Lieblich et al, 1998). As Creswell (2014) and Patton (2002) insist, respect of the school timetable, schedules, and/or programs was observed and minimal disruption was maintained. This was made possible through among other things, organizing the field trips during students' extra study hours, especially when the chosen topics did not align with the school timetable.

Chapter 4: Findings and analysis

Introduction

The study presented in this thesis explored the effect of contextualized science curricular experiences on students' learning and their teachers' teaching in a Tanzanian context. In particular, the study intended to observe, analyze, and interpret students' and teachers' views/perceptions towards the science learning that integrates both classroom and out of classroom real life learning activities, to investigate how this way of learning impacts students' learning, as well as their teacher practices of high school science teaching.

This chapter presents findings and analysis of this study's three research questions which include: 1) How do Tanzanian high school students experience science learning in a science unit that integrates both classroom and out-of-classroom real life learning activities?; 2) How does students' success in this way of science learning affect their teachers' teaching?; and, 3) What factors in the current high school science teaching and learning in Tanzania prevent teachers from employing and utilizing contextually based mediations in the teaching and learning of the school science and how these could be better addressed?

To address these research questions, data analysis involved both the quantitative data - the questionnaire responses, and the qualitative data – which comprised focus group discussion interviews with students and teachers and the researcher's field notes. This data intended to gather students' and teachers' views or perceptions of their experiences with contextualized science curricular and were collected before and after the implementation of the study, which took place over a period of eight months. The study took the form of intervention, hence data analysis covered both pre- and post experience questionnaire and focus group discussion interview responses, in order to learn how students' views or perceptions towards the learning approach changed during the period of the study.

Thus, data analysis began by subjecting the pre-experience questionnaire data to descriptive statistical analyses to examine students' initial views/ perceptions towards contextualized curricular experiences, followed by subjecting the questionnaire responses to exploratory factor analysis to explore factors or perceptual dimensions that underlay students' views or perceptions towards this approach to science learning. Since the questionnaire was Likert type, with scale points ranging from strongly-disagree to strongly-agree, the descriptive analysis involved calculating frequencies and percentages that demonstrated students' levels of agreement or disagreement with various aspects of contextualized science learning, before the beginning of the study. Determination of the pre-experience factors or perceptual dimensions was important in understanding what influenced or determined students' initial thoughts about the approach, but also, were meant to be used as codes to facilitate further analysis of their pre-experience views or perceptions collected through focus group discussion interviews.

Once determined, the pre-experience factors or perceptual dimensions were used as codes or themes to deductively analyze and interpret the pre-experience focus group discussion interviews intended to further, determine what students thought about the approach before the study commenced. This analysis was conducted by exploring how the perceptual dimensions manifested during the interviews. While the perceptual dimensions were used as analytical codes, exploring manifestations across the interview responses were intended to demonstrate the consistency of students' views or perceptions about the approach from the different data sources. Creswell (2014) refers this to as convergent parallel mixed method design where the researcher examines and analyzes the quantitative data and then uses the results to discuss the qualitative findings by way of demonstrating how data from different sources align together and/or conform to one another. Furthermore, Onwuegbuzie et al. (2010) observe that in some situations a researcher may need to elaborate and/or illustrate findings of one method with findings of another to gain deeper understanding of the issue under investigation. Yet, Lincoln and Guba (1985) posit that the use of more than one technique in data collection and analysis provides a more credible data and richer analysis than a single technique. Ultimately, the essence is to combine the quantitative data and the qualitative data in order to yield stronger evidence regarding the issue under investigation (Green, et al., 1989).

The same procedure was followed in order to analyze the post-experience data, which also constituted the students' post-experience questionnaire responses as well as their post-experience interview responses. Similar to pre-experience responses, the post-experience questionnaire responses were subjected to descriptive statistical analysis to examine students' views or perceptions, having gone through the eight months of contextualized science learning experiences. The post- experience exploratory factor analysis was then conducted, followed by the confirmatory factor analysis to find out or confirm whether or not students' perceptual dimensions changed or were maintained after the study period.

As with the pre-experience perceptual dimensions, the post-experience perceptual dimensions were used as codes or themes to guide the analysis of the post-experience focus group discussion interviews. The process involved searching for manifestations of the perceptual dimensions across the interview responses. Ultimately, the post-experience data analysis intended to find out how students' views or perceptions might have been influenced by their participation in contextualized science curricular experiences, and more specifically, learn how students understood, interpreted, and accounted for their own success in science learning having gone through the pedagogical model espoused by the present study; thus, investigating the effect of this approach to science learning.

The study also intended to interrogate how students' success within the context of this kind of science learning, influenced their teachers' teaching practices. As such, after the analysis of both pre- and post-experience students' views/perceptions, teacher interviews were analyzed to determine how their high school science teaching practices, interpreted from their views or perceptions, were influenced by their students' success in learning science through this approach. Through thematic analysis, the interview responses were examined, and the thematic categories addressing the second research question were developed (Alhojailan, 2012; Bernard, Wutich, & Ryan, 2016; Miles & Huberman, 1994; Yin, 2013). This was a rigorous process, which involved several rounds of listening to the focus group interview video clips, review of transcripts for the data set, review of the notes from my observations and informal conversations with teachers, which took place throughout the study period o (the researcher's field notes), and finally identification of the themes emergent across the data set. Three themes emerged to explain how students' success in learning science through contextualized approaches influenced their teacher practices of high school science teaching.

Finally, the study also set to identify factors in the current high school science teaching and learning in Tanzania that prevent teachers from making use of the contextually-based mediations in the teaching and learning of the school science. These factors were extracted from teacher interview responses and equally analyzed thematically to address the study's third research question.

The following section begins with presenting the analysis of the pre- and post-experience questionnaire and focus group discussion interviews with students to respond to the first research question. This section is them followed by the analysis of focus group discussion interviews with teachers in order to respond to the study's second and third research questions.

4.1 Students' pre-experience views/perceptions towards contextualized science learning

4.1.1 Pre-experience questionnaire data analysis

As introduced earlier, the descriptive statistical analysis was conducted for the pre- and post experience questionnaire responses to examine students' views or perceptions prior to and after the implementation of the study. Table 1 presents students' pre-experience views or perceptions in terms of frequencies and percentages that demonstrate the extent to which they agreed or disagreed with various aspects of the learning model (contextualized science learning), prior to implementation of the study.

As the table data indicates, although it was the first time contextual science learning was introduced to students, students endorsed most of the items that required them to provide their views/perceptions towards the approach, and particularly those that related to how school science connected with *Wajasiriamali* production activities and whether the connection would benefit their science learning.

Table 1: Students' pre-experience views/perceptions towards contextualized science learning

S/No.	Statement	SD/D	%	SA/A	%	Undecided	%
1.	School science has connection with *Wajasiriamali* production activities	6	**3.4**	152	**87.4**	16	**9.2**
2.	I think there is a lot of interesting science that we can learn through visiting and/or interacting with *Wajasiriamali* production groups	6	**3.4**	156	**89.9**	12	**6.9**
3.	My way of explaining various science ideas and concepts can change due to participation in *Wajasiriamali* learning activities	31	**17.8**	138	**79.3**	2	**1.2**
4.	Learning science through visiting *Wajasiriamali* production groups can be time consuming	63	**36.2**	85	**48.8**	26	**14.9**
5.	It is not helpful to learn science that will not be tested in exams	84	**48.3**	72	**41.4**	18	**10.3**
6.	Learning science through *Wajasiriamali* learning activities can be difficult because there are no books that explain science taking place in *Wajasiriamali* production and/or processing activities	150	**86.2**	15	**8.6**	9	**5.2**
7.	I think learning activities from *Wajasiriamali* study visits can help me to pass my exams	19	**10.9**	125	**71.8**	30	**17.2**
8.	I can confirm that the science taking place in *Wajasiriamali* production activities has relevance with that which we learn in school	9	**5.2**	151	**86.7**	14	**8.0**
9.	In order to pass exams, I need to concentrate alone rather than participate in group learning	75	**43.1**	98	**56.3**	1	**0.6**
10.	Science is involved in making *Wajasiriamali* products	8	**4.6**	155	**89.1**	11	**6.3**
11.	Learning science through *Wajasiriamali* study visits can help me to know that science is beyond classroom and laboratories	19	**10.9**	152	**87.4**	3	**1.7**
12.	Learning science through study visits is interesting	9	**5.2**	159	**91.4**	6	**3.4**
13.	The *Wajasiriamali* study visit learning activities can enforce group learning which is important in science learning	47	**27.0**	69	**39.7**	58	**33.3**
14.	I fear, if we learn science through visiting the *Wajasiriamali* we will not be able to finish syllabus	73	**41.9**	60	**34.5**	41	**23.6**
15.	The *Wajasiriamali* learning activities can help me to understand some difficult science concepts	15	**8.6**	144	**82.8**	15	**8.6**
16.	The *Wajasiriamali learning* activities can help me to better explain some science ideas to my friends	76	**43.7**	66	**37.9**	32	**18.4**
17.	Science syllabus is too long to incorporate learning activities from *Wajasiriamali*	55	**31.6**	54	**31.0**	65	**37.4**
18.	Science activities including the activities from *Wajasiriamali* study visits are only useful if they can help me to pass exams	78	**45.8**	85	**48.2**	11	**6.3**

Of all students who participated in the study, 152 (87.4%) agreed or strongly agreed that school science has connections with *Wajasiriamali* production activities; whereas, 151 (86.7%) agreed or strongly agreed that they can confirm that science involved in *Wajasiriamali* production activities has relevance with what they learn in school. Likewise, 156 (89.9%) students agreed or strongly agreed that there is a great deal of interesting science they can learn through visiting and/or interacting with *Wajasiriamali* production groups; whereas, 155(89.1%) students agreed or strongly agreed that science is involved in making *Wajasiriamali* products. On the other hand, most students supported the fact that the *Wajasiriamali* study visit learning activities could help them understand some of the difficult science concepts that they meet in class (144(82.8%)), and they believed their way of explaining various science ideas or concepts could change due to participating in *Wajasiriamali* learning activities (138(79.3%)). Eventually, students supported the fact that learning activities from *Wajasiriamali* study visits had the likelihood of helping them pass their exams (125(71.8%)).

The results indicated above offer an indication that although it was the first time this idea was introduced to students, they seemed to be well aware of the existence of *Wajasiriamali* production activities and the connection with school science, and more importantly, that these activities have the potential to enhance school science learning. This awareness of the connection between the school science and *Wajasiriamali* production activities was a green light and an important entry point through which to successfully implement the learning approach that the present study was introducing.

Other interesting results emerged with regard to the aspects that related the nature of syllabus and exams with contextualized science learning where balance existed between the number of students who agreed and those who disagreed with these aspects. While for instance, 84 (48.3%) students strongly disagreed or disagreed that it is not helpful to learn science not tested in exams, a close percentage of students 72(41.4%), agreed or strongly agreed that it is not helpful to learn science not tested in exams. Yet, 18(10.3%) remained undecided. Likewise, a balance was observed between students who agreed and those who disagreed with the fact that science activities including activities from *Wajasiriamali* study visits are only useful if they can help them to pass their exams. In this case, 85(48.2%) agreed or strongly agreed that *Wajasiriamali* study visit activities are only useful if they can help them to pass exams whereas 78(45.8%) disagreed or strongly disagreed with this aspect, and 11(6.3%) remained undecided. The fact students were divided in these aspects of exams versus this learning approach could mean although students considered the approach as generally useful they still believed the role in helping them to pass exams was paramount. Moreover, as will be seen later in the analysis of the pre-experience focus group discussion interviews, students considered what the outcomes of this pedagogical model would bring to exams as one of the important aspects to evaluate the usefulness of the model.

There were also interesting pre-experience results regarding the items related to the curricula/syllabus with this approach to science learning. About 55(31.6%) students disagreed or strongly disagreed that the science syllabus is too long to incorporate learning activities from *Wajasiriamali*, while 54(31%) students agreed or strongly agreed that it is too long to incorporate learning activities from *Wajasiriamali* , and 65(37.4%) remained undecided. Likewise, in an item asking whether they fear if they learn science through this way, they would not be able to finish the syllabus, 60(34.5%) students agreed or strongly agreed they will not be able to finish syllabus, while 73(41.9%) disagreed or strongly disagreed with this aspect, and 41(23.6%) remained undecided. The fact these two closely related items had fairly balanced results between those who agreed and those who disagreed or remained undecided could be due to the reason it was the first time students heard about the approach, or the students had some concerns regarding the syllabus versus time available to cover the topics. This was an interesting result to make a follow up during post-experience evaluation of the approach, to learn what students had to say, having participated in the study.

In general, given the fact this was the students' first encounter with contextualized science learning experiences and the pre-experience examination of their initial views or perceptions towards the approach, these results were not surprising. In fact, it was encouraging students demonstrated an awareness of the connection that existed between *Wajasiriamali* production activities and the school science, and they acknowledged the connection would be potentially useful in helping them learn school science better. Given these results, it was necessary and logical to further explore their actual views through interviews in order to learn what they actually had to say regarding this approach to high school science learning. A pre-experience focus group discussion interview conducted two days after the administration of the pre-experience questionnaire was analyzed shortly after the presentation of the exploratory factor analysis with the intention to identify factors or perceptual dimensions that underlay these students' views or perceptions prior to the beginning of the study. As noted earlier, these factors will be used as codes to guide further analysis of the focus group discussion interviews.

4.1.2 Exploring factors that underlay students' pre-experience views/ perceptions towards contextualized science learning (The pre-experience perceptual dimensions)

Assessing reliability of the instrument

The exploration of factors or perceptual dimensions that underlay students' views or perceptions towards the approach involved working with the questionnaire at the questionnaire level rather than at the individual item level. As it was in the descriptive analysis, it was important to review reliability of the modified scale before proceeding with further analyses. I therefore, computed the internal consistency reliability of the modified scale in order to assess that the degree items making up the scale were measuring the same aspect of behavior/ construct. While the Cronbach's alpha reliability of the original I_ADCLOS was 0.81 (Nashon & Madera, 2013), the Cronbach's alpha reliability of the modified scale used in the present study was found to be 0.66. Although this value was less than that of the original instrument, it was approximately the same as the minimum acceptable value of the internal consistency reliability of an instrument, which is 0.7 according to DeVellis (2016), and this made it an acceptable instrument, reliable to measure students' perceptions towards the contextual science learning.

Table 2: Reliability statistics

Admin Type	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Pre-experience	.657	.693	18

Suitability of data for Factor Analysis

Likewise, before conducting factor analysis, it was necessary to inspect suitability of the data for factor analysis (Stevens, 1996; Tabachnick & Fidell, 2007). Based on Tabachnick and Fidell (2007) criteria for sample size, the sample size (N=174) was considered sufficient for factor analysis. The inspection of correlation matrix, according to Stevens (1996), showed a substantial number of correlation coefficients above 0.3 while the evaluation index of correlation matrix, the Kaiser-Meyer-Olkin Value, was 0.613 exceeding the minimum required value of 0.6 (Kaiser, 1974). In addition, the Bartlett's Test of Sphericity (Bartlett, 1954) reached the statistical significance. Taken together, these criteria supported the factorability of the correlation matrix for this data set.

Conducting factor analysis: the Principal Component Factor Analysis (PCA)

The Principal Component Analysis (PCA) of students' perceptions prior to participating in contextualized science learning experiences revealed the presence of five components with Eigen values exceeding 1 (see Table 3). However, inspection of the scree plot revealed a somewhat clear break after the third component, showing that the first three components explained or captured much of the variance explained the remaining components (Cumulative variance = 43.58%) (see Figure 1).

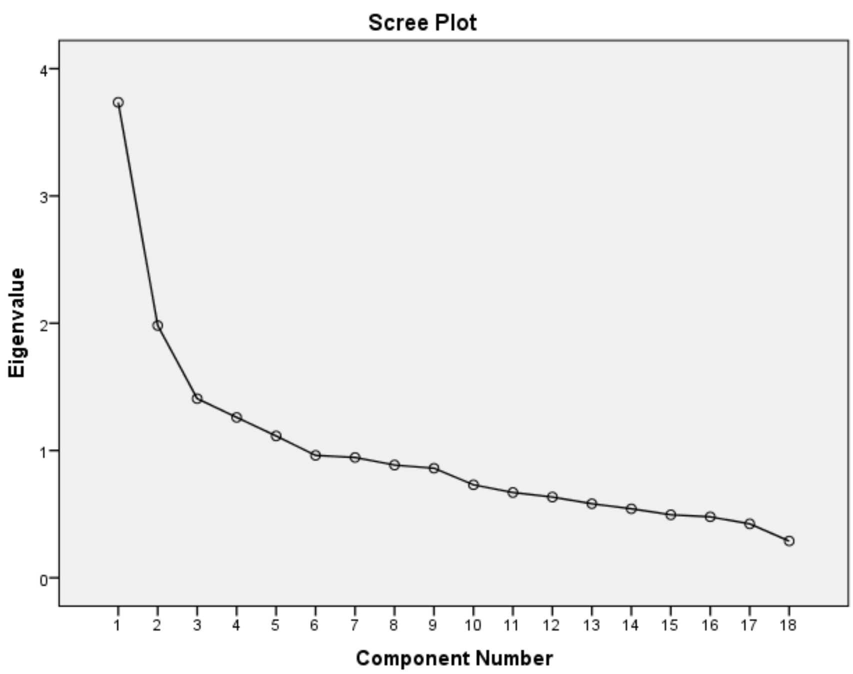


Figure 5: Scree plot displaying Eigen values of the pre-experience factors

Table 3: Total variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.794	21.078	21.078	3.794	21.078	21.078	2.763
2	2.526	14.036	35.114	2.526	14.036	35.114	2.616
3	1.524	8.465	43.579	1.524	8.465	43.579	1.696
4	1.247	6.929	50.508	1.247	6.929	50.508	2.558
5	1.203	6.684	57.192	1.203	6.684	57.192	1.858
6	.997	5.958	63.150				
7	.927	5.428	68.578				
8	.863	4.794	73.372				
9	.813	4.517	77.889				
10	.652	3.622	81.511				
11	.599	3.329	84.840				
12	.550	3.054	87.894				
13	.501	2.782	90.677				
14	.447	2.483	93.159				
15	.378	2.100	95.259				
16	.351	1.949	97.208				
17	.322	1.787	98.995				
18	.181	1.005	100.000				

Results of Parallel Analysis (see Table 4) also supported the scree test results. Out of the five components, only three components had their eigenvalues exceeding the corresponding criterion values for a randomly generated data matrix of the same size (18 variable x 174 respondents) (Horn 1965; Choi, Fuqua & Griffin, 2001).

Table 4: Parallel analysis results

Component no.	Eigen value from PCA	Criterion value from Parallel Analysis	Decision
1	3.794	1.6272	**Accepted**
2	2.526	1.4945	**Accepted**
3	1.524	1.4013	**Accepted**
4	1.247	1.3160	Rejected
5	1.203	1.2352	Rejected

Table 5: Pattern and structure matrix for PCA with oblimin rotation of three-factor solution

	Pattern Matrix			Structure Matrix		
	Component			Component		
	1	2	3	1	2	3
SP1	**.694**	-.171	-.037	**.675**	-.087	-.096
SP10	**.626**	.255	-.141	**.667**	.324	-.169
SP16	**.615**	-.280	-.127	**.589**	-.212	-.188
SP2	**.602**	.045	-.135	**.617**	.111	-.175
SP7	**.580**	-.040	.438	**.544**	.058	.395
SP11	**.547**	.348	-.026	**.592**	.414	-.043
SP15	**.534**	-.027	-.078	**.536**	.035	-.117
SP12	**.499**	.409	-.121	**.558**	.464	-.132
SP8	**.473**	.015	.187	**.462**	.085	.154
SP13	**.438**	.434	-.094	**.499**	.482	-.098
SP14	-.101	**.891**	.081	.003	**.884**	.142
SP4	-.024	**.862**	.124	.074	**.867**	.178
SP17	.487	**-.515**	-.005	.424	**-.455**	-.070
SP3	.049	**.343**	-.061	.096	**.346**	-.044
SP6	.092	.078	**.825**	.043	.139	**.824**
SP18	.084	.061	**.759**	.087	.075	**.757**
SL5	-.056	-.121	**.632**	-.116	-.089	**.629**
SP9	-.269	.074	**.465**	-.292	.069	**.489**

Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization

Finally, the inspection of Component Matrix, which shows unrotated loadings, indicated most of the items loaded quite strongly (above 0.4) on the first three components. Thus, it was decided that the oblimin rotation of the three factors conducted prior to the final decision. The rotated solution of the three components (Pattern and Structure Matrix for PCA with oblimin rotation) showed a number of strong loadings with all variables loading substantially on only one component as shown in Table 5.

From the above analysis, it was concluded that, prior to participating in contextualized science learning experiences, students had their views or perception towards this approach to science learning clustered around three factors or perceptual dimensions. The first dimension contributed to 21.08% of the total variance explained and had 10 items clustered in it (Items 1, 10, 16, 2, 7, 11, 15, 12, 8, and 13). The second dimension contributed to 14.04% of the total variance explained and had four items clustered in it (Items 14, 4, 17, and 3). While, the third dimension contributed to 8.47% of the total variance and had four items clustered in it (Items 8, 5, 6, and 9).

4.1.3 Interpreting the factors/dimensions

To interpret and name the three factors/perceptual dimensions above, I employed Pett, Lackey and Sullivan's (2003) criteria for naming. The criteria require that a researcher interpret and name a particular category by considering if there is a potential theme represented by three to four items with highest loadings in a given category. In addition to this, my interpretation was also supported by my own experience with Tanzanian science curriculum as a student, science teacher, science tutor, and a university instructor in science education, plus the formal and informal interactions I made with students before implementation of the study. Based on these, I interpreted and named the three factors/perceptual dimensions as i) Relevance and use of the pedagogical model (first dimension); ii) Nature of syllabus in relation to time (second dimension); and iii) Fear of learning non-examinable science content (third dimension). Consequently, I considered these as factors/dimensions that underlay students' views or perceptions towards contextualized science curricular experiences, prior to implementation of the study. In sum, before students participated in contextualized science curricular experiences, their views about this approach revolved around the three perceptual dimensions identified above.

Perceptual dimension 1_1: *Relevance and use of the pedagogical model*

Items in this category, as presented in Table 6, shared the same conceptual meaning, which speaks to the relevance of the school science with *Wajasiriamali* production activities. Hence, before students participated in the study, their views or perceptions towards contextualized science curricular experiences, revolved around whether or not this approach would be relevant and/or useful or appropriate for school science learning.

Table 6: Components of dimension 1_1

Item name	Description of the Item
SP1	School science has connection with *Wajasiriamali* activities
SP10	Science is involved in making *Wajasiriamali* products
SP16	*Wajasiriamali learning* activities can help me to better explain science ideas to my friends
SP2	I think there is a lot of interesting science that we can learn through visiting and/or interacting with *Wajasiriamali* groups
SP7	I think learning activities from the *Wajasiriamali* study visits can help me to pass my exams
SP11	Learning science through *Wajasiriamali* study visits can help me to know that science is beyond classroom and laboratories
SP15	The *Wajasiriamali* activities can help me to understand some difficult concepts
SP12	Learning science through study visits is interesting
SP8	I can confirm that the science taking place in *Wajasiriamali* activities has relevance with that which we learn in school
SP13	The *Wajasiriamali* study visit learning activities, can enforce group learning which is important in science learning

Perceptual dimension 2_1: *Nature of syllabus in relation to time*

With exception of item 3, other items in this category, as presented in Table 7, shared the same conceptual meaning, which speaks to the nature of syllabus in relation to time. In other words, in providing their views or perceptions prior to participating in the study, students evaluated contextualized science curricular experiences based on the extent to which the approach would agree with the nature of syllabus in relation to the time.

Table 7: Components of dimension 2_1

Item name	Description of the Item
SP14	I fear, if we learn science through visiting the *Wajasiriamali* we will not be able to finish the syllabus
SP4	Learning science through visiting the *Wajasiriamali* groups can be time consuming
SP17	Science syllabus is too long to incorporate learning activities from *Wajasiriamali*
SP3	My way of explaining various science ideas and concepts can change due to participation in the *Wajasiriamali* learning activities

Perceptual dimension 3_1: *Fear of learning non examinable science content*

Items in this category, as presented in Table 8, shared the same conceptual meaning, which relates to the fear of learning the non-examinable science content. In other words, in providing their views or perceptions prior to participating in this science learning approach, students' assessment of the approach revolved around whether or not the science that they were going to learn through the approach would be tested in their examinations.

Table 8: Components of dimension 3_1

Item name	Description of the Item
SP18	Science activities including the activities from *Wajasiriamali* visits are only useful if they can help me to pass exams
SP5	It is not helpful to learn science that will not be tested in exams
SP6	Learning science through *Wajasiriamali* learning activities can be difficult because there are no books that explain science taking place in *Wajasiriamali* production and/or processing activities
SP9	In order to pass the exam, I need to concentrate alone rather than to participate in group learning

In my post-experience analysis, I will examine these perceptual dimensions to see if they maintained or changed after students' participation in contextual science learning experiences. In the next subsection, I conduct the analysis of the pre-experience focus group discussion interviews with select group of students, guided by the perceptual dimensions identified above.

4.1.4 Analyzing the pre-experience focus group interview results

In addition to administering the pre-experience questionnaire, a focus group discussion interview was conducted with the select group of students in order to further explore the meanings they attached to their questionnaire responses before they participated in the study. My intension was to guide them expand on their views they provided through questionnaire responses by providing them with a ground on which to agree or disagree with each other on the various aspects of the model, and thereby, gain a deeper insights into how overall, they thought about contextual science learning before the beginning of the study.

The analysis that follows used the three pre-experience perceptual dimensions namely, *Relevance and use of the pedagogical model*, *Nature of syllabus in relation to time*, and *Fear of learning non-examinable science content* as thematic codes within the related student pre-experience views or perceptions were presented and discussed. As earlier stated, this analysis was conducted by way of examining how the three perceptual dimensions manifested during the interviews, thereby, locating the consistency in students' views or perceptions across the qualitative and the quantitative data collected for the study. Ultimately, this was to increase the strength of evidence regarding students' pre-experience views or perceptions towards the learning approach the study was investigating (Greene, et al. 1989; Onwuegbuzie et al., 2010).

Perceptual dimension 1: ***Relevance and use of the pedagogical model***

The first dimension that underlay students' views or perceptions prior to implementation of the study related to relevance and use of the approach. During the pre-experience focus group discussion interviews, students seemed to assess contextualized science curricular experiences based on whether or not this would be a relevant/ appropriate science learning approach given their context. In particular, students assessed the model based on mode of organization, ability to capture science content sufficiently and in general, and comparative advantages over the traditional approaches to science teaching and learning. Similar to their pre-experience questionnaire responses, students endorsed the approach during pre-experience focus group discussion interviews, subject to a few concerns they thought necessitated review and/or clarification of the learning approach before the study was implemented. Daniel and Jacqueline respectively, for instance, had the following to say when asked to provide their general views regarding the approach, prior to the beginning of the study:

> Daniel: Based on what I understand up to the moment, I have no problem with this approach. Definitely, it seems to be an interesting approach and I think it will make us learn science actively, because sometimes it can be boring sitting in class all the time without doing any activity…However, my worry is…are we going to do everything through the study visits? I mean, are we going to learn all the topics through this method? Because... some topics need to be taught thoroughly and deeply, and have many details, which I do not think all of them can be covered through study visits like these... [STD1: 60-65, May 8, 2013].

On the other hand, Jacqueline had this to say regarding this approach to science learning:

> Jacqueline: In class, we use to listen from our teachers and be given lesson notes for the topics to write. Will they give us some notes when we learn through this approach? Are we going to have time to do study visit and at the same time come back to class to write some notes? Because we are used to some teachers coming to class, talk little, and give us long notes for the topics to write. Yes, I understand, they leave us with a lot of notes to write, read, and 'swallow' / memorize [she was trying to show that this is one of the weaknesses of the traditional approach to learning]. My doubt is whether they will get time to teach us and at the same time take us to the study visits. If they can do both, then I believe this approach is going to be very much helpful to us [STD3: 67-72, May 8, 2013].

Reading through these students' initial views about the approach, one realizes how strongly they held traditional approaches to science learning. While Daniel endorsed the approach and seemed to support it was going to help them eliminate some pitfalls of the traditional approach, he was still hesitant as to whether it would be possible to cover every topic/concepts through the approach that the study was introducing and in the detail provided by the traditional approach. Similarly, Jacqueline, connecting to the questions Daniel raised, was uncertain as to whether through contextualized science learning, teachers would have enough time to teach, provide notes, and at the same time organize the study visits for more learning. From these students' pre-experience views about the approach, one realizes that, as deeply as they were entrenched into traditional approaches, students wanted to be assured they would transition from what they called 'old approach' to the 'new approach' without compromising the benefits of either approach. Students appeared to like the newly introduced contextualized science learning, yet, they wanted to retain the benefits gained from the traditional approach. This was further evident in Denis's views, which seemed to support 'merging the two approaches' rather than going with one, and here he meant, rather than going with only the 'new' approach:

> Denis: If I listened to you carefully, you said that there will be some introductory discussions about the topic, idea, or concept; then a study visit; then coming back to class to discuss and relate some concepts we learned from the study visit; and finally, write some summary notes. For me this looks good and I think it will help us deeply connect and understand the concepts better, unlike the 'old' approach…because, we will have learnt them in class, seen them during the study visits, then come to discuss them again in class. So…for me, I would go with merging the two approaches. I mean, merging the 'old' approach with these 'new' strategy, is what I think will make the approach relevant...If this is how it is going to be organized, I have a big hope that the approach will greatly help us to learn for understanding [STD10: 51-57, May 8, 2013].

Similar to Daniel and Jacqueline, Denis seemed to have endorsed the contextualized science learning and to him, the approach would be relevant and applicable to their context only if it incorporated both traditional classroom learning as well as learning in context. His view of contextualized science *learning* which emphasized on 'merging the two to make it more relevant', was strongly welcomed by other students who insisted it was the only way this approach would be made relevant and useful to them, given their context. In the same vein, Hamisa, believed if the approach would take this form, it would align with her favorite way of learning, and she was looking forward to seeing how the approach would work.

> Hamisa: …definitely, it is good to try something different. I like the fact that the approach is going to involve both classroom and study tours [I had then confirmed to them that this is how contextualized science learning would be implemented]. I am a fun of relating what we learn in school with what we do at home. Combining these approaches [she meant the traditional and the 'new' one] will help us learn and see the application of many concepts that we learn in class in a real life situation, which is different from what it used to be with the 'old' approach. …I look forward to see how this approach works. …[But] I also have a feeling that it might be so involving in terms of preparation and organization. …I think, we might need to choose only important topics to be taught through this way in order to make this approach relevant, given the nature of our syllabus, context, and time. Else, we might need to find those topics that are exactly relevant with what's being done by *Wajasiriamali* around the school or home neighborhoods, so that it becomes easy to visit them as we might not be able to travel or walk long distances in search for relevant *Wajasiriamali* groups [STD4: 15-26, May 8, 2013].

Hamisa's opinions, like other students, seem to support the approach pending careful consideration of the syllabus size, time available, and nature of content/topics. She appears to be quite worried/ hesitant of these three factors, and to her, choosing what she called 'important topics' to be taught through this approach would help making the approach more relevant and practical. Two things were learned from these student initial views in this first pre-experience perceptual dimension. First, prior to the beginning of the study, students seemed worried about how they would transition from the traditional approach to contextualized science *learning* that the present study was introducing. While they seemed to invite the approach enthusiastically, at the same time, they maintained skepticism regarding the procedures and the mode of implementation of the approach until these were collaboratively discussed and negotiated between the researcher, the teacher participants, and the students themselves during the overall preparatory classroom plenary session which took place before the beginning of the study.

Consistently as they were engrossed into traditional approach, students believed the only way to make contextualized science learning relevant and applicable was to ensure the approach borrowed some aspects of traditional science teaching and learning. They requently mentioned classroom teaching/instruction before the study visit, and provision of lesson notes after every completion of contextualized science learning cycle/ contextualized learning unit. Interestingly, during focus group discussion interviews, students consistently insisted that “combining” or “merging” the two would be “very much helpful”, even after the teacher researcher assured them that is how the approach would be organized. However, given as it was the first time the approach was being introduced , it was not surprising to encounter student concerns.

Skepticism about innovation, and particularly, learning innovations are not uncommon (Charles & Issifu, 2015; Kwek, 2011; Saidel and Tanner, 2013; Tomasetto, 2003) and can be explained by several theories. In this study, I chose the expectancy value theory of achievement motivation (Wigfield & Eccles, 2000) to explain students’ skepticism about the learning innovation the present study was introducing,. I will address this in detail later in the discussion section. Nonetheless, it is worth mentioning here that, students’ skepticism as well as the precautions accompanying their pre-experience views/ perceptions about the approach, were important in reviewing, modifying, and improving this science learning study before the beginning of the project; particularly, in creating relevance of the approach in terms of how best to organize and implement within the particular context of the study.

Perceptual dimension 2: *Nature of syllabus in relation to time*

The nature of syllabus in relation to time is another lens through which students evaluated contextualized science learning prior to the beginning of the study. Similar to their questionnaire responses, where approximately half indicated they had issues with syllabus length, during pre-experience focus group interviews, students acknowledged the potential benefits of contextualized science learning, yet shared their concerns regarding the syllabus length versus time available to cover the topics through this approach. Before participating in the study, students stated the syllabus was too ‘bulky’ and long and therefore, would require additional time to finish. In providing her pre-experience views about contextualized science learning, Maria, for instance, endorsed the approach while highlighting some concerns regarding the length of syllabus in relation to time:

> Maria: …the approach seems to be promising, because as you said, it will help us learn more about what we learn in class in a real life context. …I think it will help us to understand various concepts better as we are going to see their application in real situation rather than just reading them from books and hear them in class. I am impressed by the fact that at least now we are going to learn and see the real science. [however]…the only thing that I am in doubt with, perhaps, is whether we will be able to finish the syllabus…because, even with the old approach, in which most of the time we just sat there, listen from the teacher, and wrote some notes, some of the teachers were unable to finish their syllabus. I think when you organize the lessons, this is something that you need to consider, if this approach is to be productive and beneficial to us [STD7: 28-34, May 8, 2013].

Similarly, Neema who seemed to be excited about the approach especially because it would involve some study visits to the real life environment, demonstrated her support of the approach, but as well, she expressed caution about time, when she provided her views regarding the approach, including what she knows about *Wajasiriamali* production activities:

> Neema: Yes…I look forward to participate in the study. And actually, I am very much interested in the study visits. I kind of…wait to see how we relate various concepts that we learn in class, with what's being done by *Wajasiriamali*. I'm sure we can learn a lot from what they're doing. I know they make soaps, they make perfumes, they make tile cleaners, and they pack foods and vegetables and a lot more stuff. It is all going to be fun, I hope. Perhaps, like what Maria just said, one thing that I see could be a problem, is time. We might run short of time. I wonder if you have given it a thought. Coz…sometimes we might need to pay somehow a long walk in order to go learn something. This might consume some of our time than we expected, and in the end, perhaps, we learn something very little. So to me this is what I see we need to observe as we prepare the lessons before we begin [STD3: 36-45, May 8, 2013].

From Maria and Neema's opinions, it is clear they endorsed the approach subject to time consideration. They were somewhat worried about time. To them this could be a downside of the approach, taking into account the size of the syllabus, and as such, they thought it was crucial to consider this aspect during adoption of this type of science learning. During preparation before the beginning of the study, we considered their opinions because even the other focus group members' discussions of revealed similar feelings. We thus, took 'syllabus size versus time' aspect as among the review criteria during final preparatory discussion before the beginning of the project. Meanwhile, other students also thought about how contextualized science learning might be adopted to make the science learning more effective. One view was whether the science syllabus could be organized in such a way to provide students space/option to do their own simple observations during private time so formal study visits were saved for the areas that might require a more formal organization. Frank, had the following to say about this idea:

> Frank: …I wonder if syllabus suggests simple things that we can observe quickly and learn about science at our homes or neighborhoods so that we do not spend a lot of time to do formal preparations and visits. If this is suggested, it may help us to quickly think about, and plan some things we can relate to, observe, and learn around our homes whenever we get time or during our private time. And this would save more time for bigger things. Alternatively, teachers could prepare a summary of what we can observe every week or every other week and leave bigger things for themselves to organize [STD11: 78-85, May 8, 2013].

Students' proposals about the best way to implement the approach were a sign they were becoming aware of how the approach was to be enacted as well as what the approach intended to achieve. Implicitly, Frank's suggestion had the intension to make the approach simple, manageable, and time friendly. What was observed during pre-experience focus group discussion is that, although every student seemed to be looking forward to participating in contextualized science learning lessons they wished to see that all was well organized to meet expectations, theirs as well, which were mainly syllabus coverage and ensuring the approach helped them to pass exams. For example, regarding the issue of syllabus size versus time, Aisha was of the view that for this approach to be successful, the longer syllabus needs to be reviewed so that similar topics are combined and repetitive ones removed. She was in support of the then old proposal from the curriculum developers where three science subjects are combined so similar/ related topics are merged and taught as one theme:

> Aisha: …you know this approach make a lot of sense to me, compared to the old one… However, I think science syllabus seem to be too big to be able to do things, all like this, given the time limits. I remember there was a time when, for some reasons, they wanted to combine the three science subjects. To me this would help remove unnecessary topics, combine similar topics together, and so, reduce the syllabus size. We would have saved more time to learn things in details, practically and in real life like what you are saying. And since this method involves learning how and where people apply various science concepts, putting similar concepts together would help us easily relate them and see how they are applied together. Or else, with the three subjects separately, time might be a hindrance. In addition, it may be difficult for us especially if we want to learn how different ideas or concepts connect together especially in an applied situation [STD9: 47-57: May 8, 2013].

Although Aisha's idea of combining the subjects was obsolete in the sense it was already passed by the curriculum development authority that the three subjects are to be taught separately, her idea gained overall approval from other focus group discussion members especially with regard to connecting science ideas or concepts in applied situations. In fact, when Aisha was asked to provide an example to support her ideas, she gave a simple and interesting example:

> Aisha: …we learn food preservation in biology, for instance. One method is freezing the food. And when we freeze, we talk about seizing or reducing bacterial activity to prevent food from going bad. Yet, freezing is also in chemistry…we may say by

> freezing the food, we seize some chemical reactions so that the food remains unchanged…right? Freezing is also in physics! …we learn states of matter and how you can move from one state to another… So, you can see the way one concept is applied in different subjects. Learning them together, would make it easy to understand and apply them, but also reduce unnecessary repetitions, all together. Mine is just a simple example, but I know there are a lot others [STD9: 61-67, May 8, 2013].

All focus group discussion members embraced Aisha's example and were so inspired they began to share more examples of how ideas or concepts in the three subjects might relate or work together in applied situations. The group members found this idea helpful to saving time to allow for more *learning*. It was interesting how the discussion moved from syllabus versus time constraint, to relating science ideas and concepts in real world situation, to rationalizing how combining/teaching together similar ideas or concepts would save time while resulting in more [meaningful] learning.

I, together with the teacher participants, made use of these different student opinions during final preparation discussion session with all students for the review of the approach before we began to implement the study. Thus, we agreed because syllabus amendment was beyond the scope of this study, during study visits to *Wajasiriamali* manufacturing and processing sites, students would learn by way of exploring how ideas or concepts from different science and math subjects relate to one another, connect, and/or work together in applied situations. We believed through this process, students would learn the concepts as well as be able to relate and apply or learn their application in various situations. In the end, instead of reducing the syllabus size physically, we considered reducing the syllabus size indirectly by saving time through learning various concepts together.

Perceptual dimension 3: ***Fear of learning non examinable science content***

Results of the pre-experience focus group discussion interviews showed that prior to the beginning of the study, students also evaluated contextualized science learning based on whether or not what they were to learn through this approach would be tested in their exams. Alongside endorsing the approach, students wanted to be assured they were going to engage with an approach that would be beneficial to them not only in terms of knowledge gaining but also in terms of performance in their exams. Because of the highly exam oriented nature of curriculum in Tanzania, most students measured their effort into learning as being worthwhile when it was to bear fruits in their exams. It was therefore not surprising that during pre-experience focus group discussion interviews, questions such as, "will it come in our exams?", "will it be asked", "are you going to test this?" . The question "Is there a possibility that this can be asked?" popped up many times. In an informal discussion taking place as we walked to the focus group discussion room, Daniel had the following to say regarding this science learning approach when I asked him about the approach at that point in time:

> Daniel: …tell you what sir, most of the students will obviously like this, because, this is the first time that we conduct study visits with the intension to observe and learn things that we learn in class... However, you should not be surprised to hear them asking if 'this will come in the exams'. Yes, we have been having study visits occasionally. However, these have taken the form of random observations rather than the focused ones…. While this is going to be fun, it is also going to be a real learning

space for us. And to me, this is what I see matters most to us in this approach… When you introduced it to us, everyone was like, wow… "We are going to see soap making", "we are going to learn food processing", "we are going to see how they make cheese and butter" etc… However, all I know eventually is that, they [students] are going to take this approach more serious and consider it an opportunity to learn, once they know that there will be questions coming during exams [STD1: 3-12, May 8, 2013].

In Daniel's view, contextualized science learning was going to make a difference in their regular classes. Yet, in his view, like other students, the approach would be considered fruitful if it supported them during exams; that is, if it contributed to their better performance in exams. In other words, while students supported the approach, their pre-experience views were such that the impact on their exams was a prime factor. As Daniel projected, the issue of this learning approach versus exams emerged occasionally during focus group discussion interviews, where students became at times indirect and sometimes explicit about it, congruous to their pre-experience questionnaire results where they seemed to be divided about this issue. Whereas some students wanted to know whether the approach would involve choosing specific exam topics, others wanted to know whether there would be questions directly related to what they observed during the *Wajasiriamali* study visits. All in all, the focus was on exams. Abdul and Mwanaisha respectively asked about this during pre-experience focus group discussion interview:

Abdul: …So sir in this approach, are you planning to select some topics? I mean, does it involve selection of some relevant topics? Or we will learn all the topics this way? I'm just curious. I wonder if we are going to select topics that usually appear in exams…because as I know, those are the ones that will attract most of us into this

> learning approach [he and other students gave some smile, showing that they were endorsing]…This approach seem to involve learning for understanding rather than memorization. To me, it will be of much help during exams…because through this, I believe we can be able to explain things in our own ways rather than recalling from what we memorized from books. If I were to suggest, I would say let us go with choosing important topics rather that dealing with everything [his comment was about focusing on those that appear frequently during exams] [STD11: 56-64, May 8, 2013].
>
> Mwanaisha: …We are used to study from textbooks, and read our lesson notes for exams. Will there be questions directly related to what we observe during study visits? From *Wajasiriamali*? I mean will they ask questions directly related to what's being done by *Wajasiriamali* or something related to that? I would love to see if I could explain things that we learn in class using the knowledge that I learnt from *Wajasiriamali* [STD8: 66-70, May 8, 2013].

Reading Abdul and Mwanaisha's comments/questions, the comments carries an acknowledgement and a belief that contextualized science learning had advantages over the traditional approach. However, this could not suppress the issue of exams was at the core of the discussions. Students believed the approach was going to eliminate rote memorization, which was consistent with their pre-experience questionnaire responses, which showed that most of them believed that the contextual learning activities (from *Wajasiriamali* study visits) would help them understand and better explain difficult science ideas or concepts. Yet, their concern about time indicated they did not want to waste time with topics not frequently appearing in their exams. For example statements such as 'we do not have to deal with things that will not be examined, or “we should be sure that what we learn through contextualized science learning is examined, ‘lest not spend time uselessly’.’

Clearly, students demonstrated some concerns about this, and they needed to be assured the science they were going to learn through *Wajasiriamali* study visits (the contextualized science learning), was part of and would contribute to their better performance in exams. Neema’s views when she was asked to provide her opinion about this approach versus exams were vivid:

> Neema:…since most of the questions that they ask are very much based on what we learn from textbooks, it would be good to know what to concentrate with when we are there [when visiting *Wajasiriamali* production sites], lest not waste much of our time to learn something that will not come in our exams… [STD5: 83-85, May 8, 2013].

4.1.5 Summarizing the pre-experience results

The purpose of the pre-experience data analysis was to examine students’ initial views or perceptions towards contextualized science curricular experiences, prior to implementation of the study. Based on the pre-experience questionnaire responses and as the students responded further through the pre-experience focus group discussion interview, students clearly supported the approach and were of the view that it was going to make a difference by creating space as they argued, for ‘learning for understanding’ rather than ‘memorization of facts’. However, since this was the first time the approach was introduced to the students, they also demonstrated skepticism regarding how the approach was going to be carried out in order to benefit them. Despite their positive view about the approach, students showed some concerns around: the length of syllabus versus time; whether some elements of the traditional approach to science teaching and learning such as teaching details and giving lesson notes would be retained; or whether or not what they learnt from *Wajasiriamali* manufacturing and processing activities would be examined. More precisely, prior to implementation of the study, students were in support of the approach, except they remained skeptical about how they were going to transition from the ‘old’ (traditional) approach to the ‘new’ one (contextualized science learning) without compromising the benefits of either of the approaches.

Students’ skepticism regarding contextualized science learning introduced in the present study is not a new phenomenon when initiating learning innovations to a community of learners. Theories have explained why individuals would question, doubt, or even resist the incoming new ideas and/or practices within their learning communities. One theory that could explain this is the expectancy value theory of achievement motivation (Wigfield, 1994; Wigfield & Eccles, 2000). According to this theory, peoples’ decision to do or engage with a particular task depends on the belief there are advantages in executing or engaging with the task, and the belief they can succeed. Consistently, the choice to persist, as well as the performance in a certain task, activity, or endeavor, is a function of beliefs about how well they will do in the activity and the extent to which the activity will be successful and bring positive results (Wigfield & Ecccles, 2000).

From the point of view of this theory then, the students’ decision to adopt the approach the present study was introducing seemed to be highly dependent on the belief the approach would bring positive results, and in this case, compared to the traditional approach to science teaching and learning. Given that it was the first time that contextualized science learning was being introduced to them, and, based on the expectancy value theory of achievement motivation, it was highly likely students would have reservations/skepticism pending the successful implementation of the approach. As earlier noted, the pre-experience evaluation of the approach through the questionnaire and interviews was important in introducing the approach to students. As well it piqued their curiosity and interest towards learning science this way; plus it assessed their initial impression of the approach. Their initial views about contextualized science learning were important in rethinking the approach including the best way the approach would be organized and enacted/implemented to make it both context and cultural relevant.

In the next section, I analyze students' post-experience questionnaire and interview responses in order to examine their views or perceptions towards contextualized science learning having participated in the study. In doing so, I examine whether their perceptions and hence, perceptual dimensions changed or were maintained having gone through the contextualized science curricular experiences, and any effect this approach had on their science learning demonstrated by their views or perceptions.

4.2 Students' post-experience views/perceptions towards contextualized science curricular experiences

4.2.1 Post-experience questionnaire data analysis

The identical questionnaire used to explore students' pre-experience views/perceptions, was administered post-experience in order to learn if there were changes in students' views or perceptions, hence, their perceptual dimensions, having gone through the eight months contextualized science learning classes. Table 9 presents students' post-experience views/perceptions in terms of frequencies and percentages that demonstrate the degree to which they endorsed various aspects of the approach after they had participated in the study.

Table 9: Student post-experience views/perceptions towards contextualized science learning

S/No.	Statement	SD/D	%	SA/A	%	Undecided	%
1.	School science has connection with *Wajasiriamali* production activities	1	**0.6**	168	**99.4**	0	0
2.	I think there is a lot of interesting science that we can learn through visiting and/or interacting with *Wajasiriamali* groups	3	**1.8**	165	**97.6**	1	0.6
3.	My way of explaining various science ideas and concepts can change due to participation in the *Wajasiriamali* learning activities	2	**1.2**	165	**97.6**	2	1.2
4.	Learning science through visiting *Wajasiriamali* production groups can be time consuming	117	**69.2**	47	**27.8**	5	**3.0**
5.	It is not helpful to learn science that will not be tested in exams	146	**86.4**	19	**11.2**	4	**2.4**
6.	Learning science through *Wajasiriamali* learning activities can be difficult because there are no books that explain science taking place in *Wajasiriamali* production and/or processing activities	108	**63.9**	57	**33.7**	4	**2.4**
7.	I think learning activities from *Wajasiriamali* study visits can help me to pass my exams	5	**2.9**	162	**95.9**	2	**1.2**
8.	I can confirm that the science taking place in *Wajasiriamali* production activities has relevance with that which we learn in school	1	**0.6**	167	**98.8**	1	**0.6**
9.	In order to pass the exam, I need to concentrate alone rather than participate in group learning	136	**80.5**	30	**17.8**	3	**1.8**
10.	Science is involved in making *Wajasiriamali* products	4	**2.4**	165	**97.6**	0	**0**
11.	Learning science through *Wajasiriamali* study visits can help me to know that science is beyond classroom and laboratories	4	**2.4**	163	**96.4**	2	**1.2**
12.	Learning science through study visits is interesting	3	**1.8**	165	**97.6**	1	**0.6**
13.	The *Wajasiriamali* study visit learning activities can enforce group learning which is important in science learning	5	**3.0**	158	**93.5**	6	**3.6**
14.	I fear, if we learn science through visiting *Wajasiriamali* we will not be able to finish syllabus	151	**89.3**	16	**9.5**	7	**4.1**
15.	The *Wajasiriamali* study visit learning activities can help me to understand some difficult science concepts	3	**1.8**	163	**96.4**	3	**1.8**
16.	The *Wajasiriamali* study visit *learning* activities can help me to better explain some science ideas to my friends	6	**3.6**	153	**90.5**	9	**5.3**
17.	Science syllabus is too long to incorporate learning activities from *Wajasiriamali*	148	**87.5**	15	**8.9**	6	**3.5**
18.	Science activities including the activities from *Wajasiriamali* study visits are only useful if they can help me to pass exams	154	**91.1**	11	**6.5**	4	**2.4**

As the table indicates, students' post-experience evaluation of the approach shows that having gone through contextualized science learning experiences, their support of the approach increased dramatically in almost all the aspects of the approach. There was a remarkable change in their views/perceptions such that those who initially opposed, or were uncertain about the approach, shifted their positions to agree or strongly agree, or in some aspects, disagree and strongly disagree in support of the approach. The percentage of those in the undecided position also dropped significantly. In particular, students who were in agreed or strongly agreed positions with regard to the aspects that related to connection between the school science and *Wajasiriamali* production activities, and those that related to the likelihood that this learning approach would enhance science learning, increased from 70 and 80 percent pre-experience, to above 95 percent post-experience.

For instance, in responding to the item that required students to provide their views on whether or not school science has connection with *Wajasiriamali* production activities, 168(99.4%) students agreed or strongly agreed there is a connection, while only one (0.6%) student disagreed. Likewise, 165(97.6%) students agreed or strongly agreed that science is involved in making *Wajasiriamali* products, whereas 167(98.8%) students agreed or strongly agreed that they can confirm that science taking place in *Wajasiriamali* production activities has relevance with what they learn in school. Furthermore, 165(97.6%) students agreed or strongly agreed that their way of explaining science ideas or concepts can change due to participating in *Wajasiriamali* learning activities, whereas 163(96.4%) students agreed or strongly agreed that *Wajasiriamali* learning activities can help them understand some difficult science concepts. Compared to the pre-experience results, what these results indicate is having gone through contextualized science curricular experiences, almost all students confirmed there was a strong connection between the school science and the real-world *Wajasiriamali* learning experiences, and that these experiences have the potential to support school science learning.

Similar to the items linking *Wajasiriamali* production activities with the school science, students also shifted their position with regard to the items relating *Wajasiriamali* learning activities with exams in support of the approach. While for instance, in the pre-experience, 125(71.8%) students agreed or strongly agreed while 30(17.2%) were undecided about the fact learning activities from *Wajasiriamali* study visits can help them pass their exams, post-experience results showed 162(95.9%) students agreed or strongly agreed with this aspect, while only 2(1.2%) remained undecided. Almost all undecided students agreed with this aspect. Furthermore, whereas prior to implementation of the study, 72(41.2%) students had agreed or strongly agreed that it is not helpful to learn non-examinable science content, most of these students shifted their position post-experience, such that 146(86.4%) disagreed or strongly disagreed with the fact that it is not helpful to learn science that will not be examined, while 19(11.2%) remained in agreed position and two (2.4%) in undecided position. Consistently, in responding to an item that science activities from *Wajasiriamali* study visits are only useful if they can help them pass their exams, 85(48.2%) students had agreed with this aspect pre-experience, whereas post-experience results showed that 154(91.1%) students disagreed or strongly disagreed that study visits are only useful if they can help them pass their exams. These results provide an implication that even though students believed that the approach could help them pass their exams, having gone through contextualized science curricular experiences, they seemed to no longer care about whether or not the science they learned through this approach would be tested in their exams. In other words, contrary to their pre-experience perceptions, which showed they had some concerns regarding whether or not, what they learned through *Wajasiriamali* would be examined; their post-experience perceptions showed that learning, plus what they learned, turned out to be of prime importance rather than being tested on what they learned through this approach.

Students also demonstrated an interesting shift in the aspects that related syllabus size with contextualized science learning. Prior to implementation of the study, they seemed to be divided about whether or not the syllabus was too long to incorporate learning activities from *Wajasiriamali*, where, 55(31.6%) disagreed or strongly disagreed, 54(31.0%) agreed or strongly agreed, and 65(37.4%) were in undecided position. However, post-experience results showed that 148(87.5%) students disagreed or strongly disagreed the syllabus was too long to incorporate learning activities from *Wajasiriamali*, while only 15(8.9%) agreed or strongly agreed, and six (3.5%) remained undecided. Consistently, prior to implementation of the study, students were divided in responding to the item asking them whether they fear if they learn science through visiting *Wajasiriamali*, they will not be able to finish syllabus. About 73(41.9%) disagreed or strongly disagreed, 60(34.5%) agreed or strongly agreed, and 41(23.6%) were undecided. However, post experience results showed a strong shift in position, where, 151(89.3%) students disagreed or strongly disagreed with this aspect, which means that they had no fear of not being able to finish syllabus, if they learnt science through contextualized learning approaches. Only 16(9.5%) agreed or strongly agreed with this aspect and seven (4.1%) remained undecided. This consistent shift in position regarding the length of syllabus/syllabus size could be an indication that, having experienced contextualized science learning, syllabus length/size was no longer an issue at the forefront of the students, rather, the benefit they gained through learning science by using this approach.

It could therefore be sufficient to say that after the eight months of contextualized science learning experiences, students seemed to confirm the connection between the school science and *Wajasiriamali* production activities, and acknowledged the potential this connection has in supporting school science learning. Besides, the results show that students took the position that, although finishing the syllabus and passing exams were important, the science they learned through *Wajasiriamali* study visits appeared to be far more important.

However, despite these results from questionnaire response, it was crucial to learn further from their own words, what they had to say regarding this approach, having gone through the entire science-learning project. More specifically, it was important to learn the meaning they attached to their quantitative responses by reviewing their interviews responses in order to gain deeper understanding of their thoughts regarding the influence of this approach on their science learning throughout the study. Results of the post-experience focus group discussion interviews with students will be presented and analyzed in the next section. The same procedure will be followed as was done with the pre-experience results where the pre-experience factors/ perceptual dimensions were used as codes to guide the analysis of the pre-experience focus group discussion interviews. Yet, in order to determine the factors (from the quantitative results) to be used to interrogate data from the focus group discussion interviews (the qualitative data), the exploratory factor analysis (EFA), followed by the confirmatory factor analysis (CFA) were done with the post-experience questionnaire results. Although this may appear to be a violation of methods, because one would expect consistency in the factors/ or perceptual dimensions, it was not the case with the present study.. Given the fact students were experiencing a shift from the old learning approach (the traditional learning approach) to the new learning approach (seemingly better), it was anticipated a change in their perceptual dimensions might occur. Hence, the need to re-examine and confirm the factors/ perceptual dimensions before proceeding with the analysis of the post-experience focus group discussion interviews.

The subsection that follows presents an exploratory factor analysis (EFA) that entailed a reexamination in order to determine any changes in factors / perceptual dimensions that underlay students' views or perceptions, post-experience, and subsequently, confirmed through confirmatory factor analysis (CFA). Similar to the pre-experience data analysis, the dimensions will then be used as codes to guide analysis of the post-experience focus group discussion interviews with students.

4.2.2 Exploring factors that underlay students' post-experience views/perceptions towards contextualized science curricular experiences (Post-experience perceptual dimensions)

Assessing reliability of the instrument

Similar to the pre-experience exploratory factor analysis, it was also necessary that the internal consistency reliability of the modified questionnaire checked for the post-experience data in order to assess its reliability before proceeding with further analysis. While the Cronbach's alpha reliability of the original I_ADCLOS was 0.81 (Nashon & Madera, 2013), the calculated Cronbach's alpha reliability for the modified instrument, based on the post-experience data was found to be 0.68, which is approximately the same as the minimum acceptable value of the internal consistency reliability of an instrument, which according to DeVellis (2016) is 0.7. This made it an acceptable instrument, reliable to measure students' perceptions in the present study (see Table 10).

Table 10: Reliability statistics

Reliability Statistics

Visit type	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Post-visit	.684	.752	18

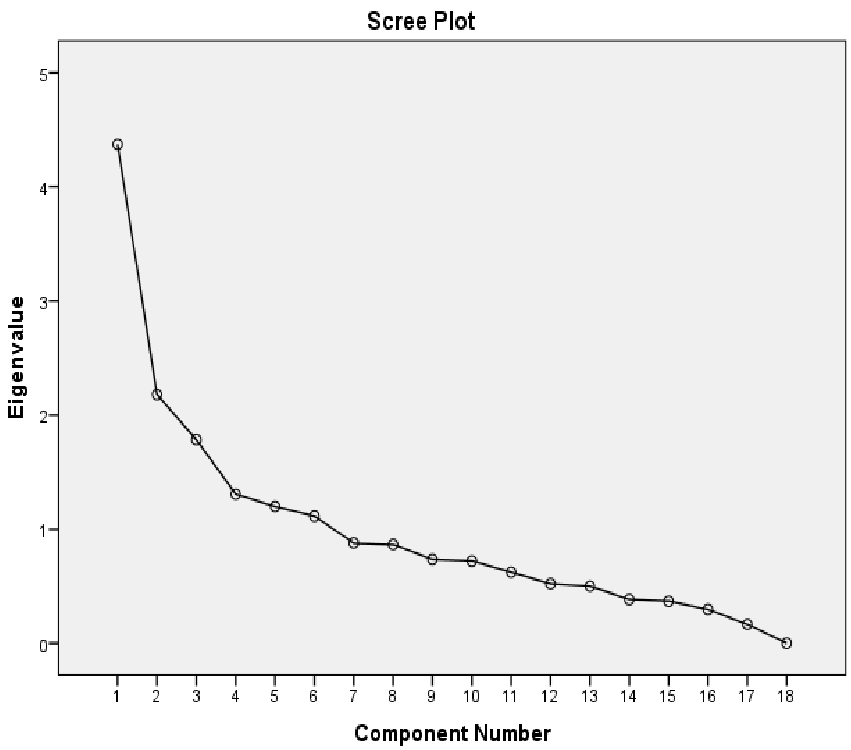
Suitability of the data for Factor Analysis

It was also necessary to inspect suitability of the post-experience data for factor analysis (Tabachnick & Fidell, 2007; Stevens, 1996). Based on Tabachnick and Fidell (2007) criteria of sample size, the sample size (*N*=169) was considered sufficient for factor analysis. The inspection of correlation matrix according to Stevens (1996) showed a significant number of correlation coefficients above 0.3, while evaluation index of correlation matrix, that is, the Kaiser-Meyer-Olkin Value was 0.71, exceeding the minimum required value of 0.6 (Kaiser 1974). In addition, the Bartlett’s Test of Sphericity (Bartlett, 1954) reached the statistical significance. Together, these criteria supported the factorability of the correlation matrix for the post-experience data.

Conducting factor analysis: the Principal Component Factor Analysis (PCA)

The Principal Component Analysis (PCA) of the post-experience student perceptions toward contextualized science learning revealed the presence of nine components with Eigen values exceeding 1 (see Table 11). However, inspection of the scree plot revealed two noticeable breaks after the third and fourth components, hence decided that four factors be retained for further investigation (see figure 2).

Results of Parallel Analysis also supported the scree test results (see Table 12). In this case, only four out of the nine initially extracted components had Eigenvalues exceeding the corresponding criterion values for a randomly generated data matrix of the same size (18 variable x 169 respondents) (Horn 1965; Choi, Fuqua & Griffin, 2001).



Fugure 6: Scree plot displaying Eigen values of the post-experience factors

Table 11: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[c]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2.441	13.561	13.561	2.441	13.561	13.561	1.944
2	1.965	10.915	24.476	1.965	10.915	24.476	1.642
3	1.499	8.326	32.802	1.499	8.326	32.802	1.560
4	1.394	7.147	40.549	1.394	7.147	40.549	1.921
5	1.240	6.888	47.437	1.240	6.888	47.437	1.378
6	1.154	6.410	53.847	1.154	6.410	53.847	1.178
7	1.131	6.284	60.131	1.131	6.284	60.131	1.248
8	1.051	5.842	65.972	1.051	5.842	65.972	1.261
9	1.037	5.761	71.733	1.037	5.761	71.733	1.357
10	.868	4.825	76.558				
11	.780	4.334	80.892				
12	.664	3.686	84.578				
13	.649	3.607	88.185				
14	.523	2.907	91.092				
15	.481	2.670	93.762				
16	.444	2.469	96.232				
17	.379	2.107	98.338				
18	.299	1.662	100.000				

Extraction Method: Principal Component Analysis

Table 12: Parallel analysis results

Component no.	**Eigen value from PCA**	**Criterion value from Parallel Analysis**	**Decision**
1	2.441	1.6035	**Accepted**
2	1.965	1.4777	**Accepted**
3	1.499	1.3852	**Accepted**
4	1.394	1.3070	**Accepted**
5	1.240	1.2568	Rejected
6	1.154	1.1693	Rejected
7	1.131	1.1100	Rejected
8	1.051	1.0520	Rejected
9	1.037	1.0040	Rejected

Before a final decision was made, a further exploration of the SPSS output i.e. the inspection of Component Matrix, which shows the un-rotated loadings, indicated that most of the items loaded quite strongly (above .4) on the first four components. As a result, it was decided that direct Oblimin rotation of the four factors be conducted prior to the final decision concerning the number of factors. Pattern Matrix results indicated the loadings (above .3) of seven items on component 1, six items on component 2, four items on component 3, and only one item on component 4. Since ideally, each component needs to have three or more items loading on it (Pett, Lackey, & Sullivan, 2003; Tabachnick & Fidell, 2007), component four was excluded and Oblimin rotation of the three components repeated. Final results showed that the three components had strong loadings with all variables/items loading substantially on only one component as shown in Table 13.

Table 13: Pattern and Structure Matrix for PCA with Oblimin Rotation of Four-factor solution

	Pattern Coefficients			Structure coefficients		
	Components			Components		
	1	2	3	1	2	3
SP14	**-.793**	.050	-.070	**-.755**	.113	-.046
SP4	**-.675**	-.204	.305	**-.584**	.358	.042
SP6	**-.661**	.317	.032	**.578**	-.360	.077
SP9	**.556**	-.313	.083	**-.571**	-.172	.336
SP2	**.514**	-.291	-.014	**.550**	.031	-.029
SP11	**-.508**	-.142	-.180	**.515**	-.303	-.146
SP13	**-.478**	-.004	-.236	**-.405**	-.150	-.207
SP10	.183	**-.767**	-.025	.222	**-.757**	-.011
SP1	-.107	**.752**	-.183	-.132	**.645**	-.198
SP8	.255	**.628**	-.235	.242	**.602**	.221
SP7	.054	**-.585**	.140	.076	**-.576**	.154
SP12	-.013	**-.565**	-.003	.019	**-.516**	.023
SP5	.198	**-.558**	-.312	.230	**-.405**	-.301
SP16	-.189	.029	**.736**	-.181	.033	**.716**
SP3	-.290	-.261	**.706**	-.299	-.267	**.622**
SP18	-.198	-.186	**.642**	-.154	-.145	**-.538**
SP15	.006	.180	**-.533**	.014	.180	**-.507**

Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization

From the above analysis, it was concluded that having gone through the eight months contextualized science learning experiences, students still had their views or perception towards this approach to science learning, clustered around three factors or perceptual dimensions. The first dimension contributed to 13.56% of the total variance explained and had seven items clustered in it (Items 14, 4, 6, 9, 2, 11, and 13). The second dimension contributed to 10.92% of the total variance explained and had six items clustered in it (Items 10, 1, 8, 7, 12 and 5). While the third dimension contributed to 8.33% of the total variance explained and had four items clustered in it (Items 16, 3, 18 and 15). The three factors, thus, contributed 32.81% of the total variance explained. In other words, 32.81% of the total variance of the students' views or perceptions towards contextualized science learning could be explained by the three factors, while the remaining percent could be accounted for by other factors not explored by the present study.

A further examination of the variables constituting each of the three post-experience factors/ perceptual dimensions revealed that the first two pre-experience perceptual dimensions were retained post-experience, albeit some rearrangement of items within, as well as across the factors / dimensions, whereas the third pre-experience perceptual dimension became suppressed. None of the items in the third factor was retained post-experience. A new dimension thus emerged that contained items related to students' ability to understand and explain various science ideas or concepts, different from the third pre-experience dimension, which related to fear of learning non-examinable science content. This is in fact, consistent with students' post-experience views/perceptions (based on their post-experience questionnaire responses, and as will be seen later in the analysis interviews), in which students seemed to have valued the knowledge that they gained by learning science through this way, rather than caring about whether or not the science that they learned would be examined. A confirmatory factor analysis (CFA) conducted to confirm the existence of the three factors post-experience, also confirmed the three-factor model as seen in the best-fit indices of the model in table 14 below.

Table 14: Confirmatory factor analysis of the post-experience perceptual dimensions

Model	RMSEA	SRMR	CFI	TLI	AIC	BIC	Log likelihood
3-Factor model	0.061	0.058	0.85	0.88	6,568	6,684	-3,247

NB: The requirement for RMSEA is 0.06 or less; SRMR - 0.08 or less; CFI, TLI - 0.90 and above; and AIC, BIC, and Log likelihood – the lesser the better (Aho, Derryberry & Peterson, 2014; Claeskens & Hjort, 2008).

It should be noted that given the nature of intervention, and the intended students' learning, it would not have made pedagogical sense to do t-test to check for pre and post experience factors for there existed a possibility that the factors could change. In other words, the factor structure would likely change.

4.2.3 Interpreting the dimensions

Similar to the pre-experience perceptual dimensions, I interpreted the post experience perceptual dimensions based on Pett, Lackey and Sullivan's (2003) criteria for naming, which require a researcher interpret and name a particular category by considering if there is a theme that might be represented by three to four items with highest loadings in a given category. Moreover, my interpretation was also shaped by the nature of students' post-experience questionnaire responses; informal observation, interaction, and conversations that I made with students during the period of the study; plus, my own experience with the Tanzanian science curriculum as a student, a teacher, a tutor, and a university instructor. Based on these, I interpreted and named the three dimensions as i) Nature of syllabus in relation to time, ii)

Relevance and use of the pedagogical model, and iii) Ability to understand and explain various science ideas or concepts. I eventually, considered these as perceptual dimensions that underlay students' post-experience views or perceptions towards contextualized science learning experiences. In other words, having participated in the lessons that were modeled in this way of science learning, students' post-experience evaluation of the approach, revolved around the three perceptual dimensions identified above.

Perceptual dimension 1_2: *Nature of syllabus in relation to time*

Items in this category, as presented in Table 15, shared a common theme, which speaks to the nature of syllabus, teaching methodology and time. In other words, students provided their post-experience assessment of the approach by looking at the relationship between this approach to science learning versus the nature of syllabus and time available to cover the syllabus through the approach.

Table 15: Components of dimension 1_2

Item name	Description of the Item
SP14	I fear if we learn science through this way we will not be able to finish the syllabus
SP4	Learning science through visiting the *Wajasiriamali* groups can be time consuming
SP6	*Learning* science through *Wajasiriamali* learning activities can be difficult because there are no books that explain science taking place in *Wajasiriamali* activities
SP 9	In order to pass exam I need to concentrate alone rather than participate in group learning
SP2	I think there is a lot of interesting science that we can learn through visiting and/or interacting with *Wajasiriamali* groups
SP11	Learning science through the *Wajasiriamali* study visits can help me to know that science is beyond classroom and laboratories
SP13	Post-*Wajasiriamali* study visit learning activities can enforce group learning which is important in science learning

Perceptual dimension 2_2: ***Relevance and use of the pedagogical model***

Items in this category, as presented in Table 16, shared a common theme, which speaks to the relevance of contextualized science learning with the school science. In other words, students provided their post-experience views/perceptions towards contextualized science curricular experiences, based on the extent to which the approach was relevant with/for school science learning, and particularly with their strive to succeed academically.

Table 16: Components of dimension 2_2

Item name	**Description of the Item**
SP10	Science is involved in making the *Wajasiriamali* products
SP1	School science has connection with *Wajasiriamali* learning activities
SP8	I can say that the science taking place in *Wajasiriamali* production activities has relevance with that which we learn in school
SP7	I think learning activities from the *Wajasiriamali* study visit can help me to pass my exams
SP12	Learning science through study visits is interesting
SP5	It is not helpful to learn science that will not be tested in exams

Perceptual dimension 3_2: ***Ability to understand and explain various science ideas or concepts***

Items in this category, as presented in Table 17, shared a common theme, which speaks to ability of the learners to understand, explain, and apply various science ideas and concepts. In other words, students provided their post-experience views/perceptions towards contextualized science learning experiences based on how they were able to understand, explain, or interpret various science ideas and/or concepts when science learning was organized and taught through this approach to science learning.

Table 17: Components of dimension 3_2

Item name	Description of the Item
SP16	The *Wajasiriamali* study visit learning activities can help me to better explain some science ideas to my friends
SP3	My way of explaining various science ideas and concepts can change due to participation in the *Wajasiriamali* group learning activities
SP18	Science activities including the activities from *Wajasiriamali* visits are only useful if they can help me to pass exams
SP15	The *Wajasiriamali* study visit learning activities can help me to understand some difficult concepts

Table 18: Item loadings in different factors pre- and post-experience

Pre-experience factor items		Post-experience factor items	
F1: Relevance and use of the pedagogical model		**F2: Relevance and use of the pedagogical model**	
SP1	School science has connection with *Wajasiriamali* learning activities	SP10	Science is involved in making the *Wajasiriamali* products
SP10	Science is involved in making *Wajasiriamali* products	SP1	School science has connection with *Wajasiriamali* learning activities
SP16	*Wajasiriamali learning* activities can help me to better explain science ideas to my friends	SP8	I can confirm that the science taking place in *Wajasiriamali* production activities has relevance with that which we learn in school
SP2	I think there is a lot of interesting science that we can learn through visiting and/or interacting with *Wajasiriamali* groups	SP7	I think learning activities from the *Wajasiriamali* study visit can help me to pass my exams
SP7	I think learning activities from the *Wajasiriamali* study visits can help me to pass my exams	SP12	Learning science through study visits is interesting
SP11	Learning science through *Wajasiriamali* study visits can help me to know that science is beyond classroom and laboratories	SP5	It is not helpful to learn science that will not be tested in exams
SP15	The *Wajasiriamali* study visit learning activities can help me to understand some difficult concepts		
SP12	Learning science through study visits is interesting		
SP8	I can confirm that the science taking place in *Wajasiriamali* production activities has relevance with that which we learn in school		
SP13	The *Wajasiriamali* study visit learning activities can enforce group learning which is important in science learning		
F2: Nature of syllabus in relation to time		**F1: Nature of syllabus in relation to time**	
SP14	I fear, if we learn science through visiting *Wajasiriamali* we will not be able to finish the syllabus	SP14	I fear if we learn science through visiting *Wajasiriamali* we will not be able to finish the syllabus
SP4	Learning science through visiting *Wajasiriamali* groups can be time consuming	SP4	Learning science through visiting *Wajasiriamali* groups can be time consuming
SP17	Science syllabus is too long to incorporate learning activities from *Wajasiriamali*	SP6	Learning science through *Wajasiriamali* learning activities can be difficult because there are no books that explain science taking place in *Wajasiriamali* production and/or processing activities
SP3	My way of explaining various science ideas and concepts can	SP9	In order to pass exam I need to concentrate alone rather than

	change due to participation in the *Wajasiriamali* learning activities		participate in group learning
		SP2	I think there is a lot of interesting science that we can learn through visiting and/or interacting with *Wajasiriamali* groups
		SP11	Learning science through the *Wajasiriamali* study visits can help me to know that science is beyond classroom and laboratories
		SP13	The *Wajasiriamali* study visit learning activities can enforce group learning which is important in science learning
F3: Fear of learning non examinable science content		**F3: Ability to understand and explain various science ideas or concepts**	
SP18	Science activities including the activities from *Wajasiriamali* visits are only useful if they can help me to pass exams	SP16	*Wajasiriamali learning* activities can help me to better explain science ideas to my friends
SP5	It is not helpful to learn science that will not be tested in exams	SP3	My way of explaining various science ideas and concepts can change due to participation in the *Wajasiriamali* learning activities
SP6	Learning science through *Wajasiriamali* learning activities can be difficult because there are no books that explain science taking place in *Wajasiriamali* production and/or processing activities	SP18	Science activities including the activities from *Wajasiriamali* visits are only useful if they can help me to pass exams
SP9	In order to pass the exam, I need to concentrate alone rather than to participate in group learning	SP15	The *Wajasiriamali* study visit learning activities can help me to understand some difficult concepts

* Item 17 (SP17) did not load in either of the three post-experience factors

*Factors 1 and 2 pre-experience swapped their position post-experience, as well as minor rearrangement of item loadings within factors

In the next section, the post-experience perceptual dimensions above are used to analyze students' post-experience views or perceptions collected through focus group discussion interviews.

4.2.4 Analyzing the post-experience focus group discussion interviews

As introduced earlier, having positively endorsed the contextual science learning in their post-experience questionnaire responses, it was important to further learn from students' own words, what exactly they had to say regarding the impact this approach had on their own learning and achievement in science, after having participated in the eight month contextualized science curricular experiences. Similar to the pre-experience focus group discussion interviews, the analysis of the post-experience focus group discussion interviews took place by way of examining how the three post-experience perceptual dimensions identified above, manifested during the interviews; thereby, locating the consistency in students' post-experience views or perceptions across the qualitative and the quantitative data collected for the study. While this would increase the strength of evidence with regard to students' views or perceptions (Onwuegbuzie et al., 2010), the aim was to also delvle deeper into their interview responses to learn how they understood, interpreted, and accounted for their own success in science learning having gone through the pedagogical model the present study was implementing.

Perceptual dimension 1_2: *Nature of syllabus in relation to time*

Similar to their post-experience questionnaire responses, during post-experience focus group discussion interviews, students seemed to consistently have positive views about contextualized science learning and they believed it made a great deal of difference when compared to a traditional approach to science learning. Unlike their pre-experience perceptions where they believed the approach would be time consuming, analysis of their post-experience views/perceptions showed they now believed time was not an issue and would not supersede the advantages of contextualized science learning. The active engagement with learning, the real-world learning context, and the use/value of the knowledge they gained through this way of science learning were over and above the issue of time and syllabus length. The approach made students believe that learning should be for understanding of the materials (i.e. the ideas and concepts), and knowing how to use/apply them in the real-world context, unlike the traditional approach which was built around memorization of facts ready to reproduce them during exams. Felix and Maria respectively, shared their general views regarding the approach during post-experience focus group discussion interview, including how helpful they believed the approach was, for meaningful learning of science:

> Felix: This project opened me up so much…You keep asking yourself 'why didn't they teach us like this since Form 1?' We have covered many interesting topics, which we could have learned better and meaningfully through this way. But we never had a single study visit to learn academic things from field experience like this. Well, I know they talk about syllabus length, and this and that… However, see within a very short time, we have covered a lot of stuff, actually useful stuff. We have learned and practiced how to make soap, a variety of soaps such as liquid soap, bar soap, laundry soap, toilet perfumes etc. We have learned and practiced how to process and preserve foods such as mango pickle, tomato sauce, soya milk, chili sauce, tomato juice etc. We learnt all these in class, in the food processing and packaging topic, but we never had chance to do it practically. We never had chance to see and try out the

procedures by ourselves…to see if it is something that we can do. Learning by seeing it and trying it out made it all nice. And I am sure, after this, you cannot easily forget the principles and procedures…The approach will help us to remember a lot of 'things' in exams, and in fact, explain them in our own words. ...more importantly, some of us might think of engaging in some of these activities after school. Because they are all done, all around in our area [STD6: 561-576, November 19, 2013].

Figure 7: Students listening carefully the procedures for powder soap making

On the other hand, Maria believed that syllabus did not do justice to them by not telling teachers to use such methods that would help them relate the school science with what they experienced in their everyday lives. She was of the view that learning for understanding was rather more important than syllabus coverage:

Maria: …I should say that this learning approach has changed me a lot…I never thought I could use my secondary level education to do something tangible, I mean to produce something useful like what he [Felix] mentioned…making soaps or making things like tomato sauce, mango pickle, or chill sauce. I thought you could only do these, when you have graduated from college or university, not at this level. You just keep wondering why didn't syllabus instruct teachers to use this approach while there is a lot of these activities going on around our home neighborhoods…This model has really inspired me. It has made me to constantly think about the application of what we learn in class, whenever we begin a new topic. Even when the teacher is not employing this method, I find myself asking, where could this be applied, say for example, at home? And when I find the application, it makes me feel like wow, now I'm learning something…not only for exams, but also for my own future use. So as Mwanaisha just said, [Mwanaisha had just mentioned, 'time should not be a barrier to learning'], to me time is not an issue. What matters is what we learn through this approach. Yes, it is important to cover the syllabus. But, coverage that goes with understanding of the materials along with ability to apply them is what to me, matters most [STD7: 578-591, November 19, 2013].

Figure 8: Liquid soap making - students taking down important notes

Reading-through these students' post-experience views about contextualized science learning, one realizes that students were very much concerned with the advantages that came with the approach. To both of them, learning for understanding and applying, which they considered 'meaningful learning', is what mattered more than time or syllabus coverage. The fact that in this approach, learning process involved seeing and experiencing the application of various science ideas and/or concepts in the real-world local context of the learners, made the whole learning real, active, and engaging and this inspired and increased students' motivation to learn.

The sentiments demonstrated by Maria, that the approach made her constantly ask herself 'where this could be applied', and the fact she believed she learned 'something useful' when she realized the application to her everyday life context align with the tenets of the contextual learning theory which guides the present study. According to contextual learning theory, learners tend to seek meaning in context, that is, in relation to their current environment, and they do so by searching for the relationships that make sense and appear to be useful (Bebington, 2004; Berns & Erickson, 2001; Hull, 1995). As such, they will consider learning as meaningful only when it involves authentic activities they find relevant, engaging and useful to them (Bebbington, 2004; Brunner, 1997; Hull, 1995).

Students in this study believed that learning through this approach helped them link school science to what is taking place in their everyday life, something which, according to them, was important not only for learning/or academic purposes, but also for non-academic or economic purposes. They saw it as an opportunity not only to enhance school science learning, but also, to learn to apply the knowledge for future engagement with the world of work through such small-scale production activities as those done by *Wajasiriamali* artisans. With the advantages that came with this approach in mind, syllabus length and time were no longer an issue; although they still recognized it as important. Daniel, a student who became fond of the approach right from the beginning of the study, acknowledged the advantages that came with contextualized science learning over the traditional approach and believed that it would be appropriate if contextualized science learning was declared the main approach to high school science teaching and learning:

> Daniel: …You see this project has happened just by chance. It is not really the way we were taught. It feels surprising why they would not teach us like this. Yes, the approach might seem time and 'energy' consuming in a way... But I think they could choose a few topics for us to experience…We cannot learn science only by just sitting there and wait to hear from teachers. Science is not like that! So for me, it would be good if syllabus suggested this as the main approach to science learning. By the way…what's the point of finishing syllabus if you cannot learn something useful…you cannot do anything tangible? I mean, do we have to learn only for exams? Take an example of those who do not get high pass marks that would allow them to join senior high school or university, which is actually, most of us! Don't you think this could be their chance to learn something that they could do after school? [STD1: 17-25, November 15, 2013].

Figure 9: Soap making – Spreading bar soap slurry ready for sun drying

In a struggling economy like Tanzania, with a significantly high rate of unemployment (UNESCO, 2011, 2015), it was interesting, and it made sense, to see students associate contextualized science learning with future career opportunities. Perhaps because, learning cycle in this approach involved a stage where students connected with the small-scale local artisanal production groups (the *Wajasiriamali* production groups) where they experienced real life application of various science ideas and/or concepts as well as principles and procedures for producing/ or processing various consumer products. Such a curriculum and learning model, according to Hull (1995) and Ultay and Calik (2002) have the potential to create an environment in which all students have the opportunity to become empowered in their learning experiences, broaden their ability to make connections, and enjoy discovery, which is important in science learning. Furthermore, Hull (1995, p. 32) asserts that it is this kind of environment where "students discover relationships between abstract ideas and real world applications…internalize concepts as they discover, and reinforce and connect those relationships". Linking the school science with the real world local contexts of the learners in this study, enabled them to see the meaning and realize the immediate application of science in their everyday lives. This had a great impact on their motivation and interest to learn science, perhaps to the extent that syllabus length and/or coverage would not supersede this advantage.

Perceptual dimension 2_2: *Relevance and use of the pedagogical model*

Relevance of the approach was another factor/dimension that underlay students' post-experience views/perceptions towards contextualized science learning. During post-experience focus group discussion interviews, students seemed to evaluate the approach based on how relevant it was for learning, and more specifically, how supportive it was for meaningful learning of the school science compared to the traditional approach to science *learning*. Students considered the model relevant because it demonstrated the potential to help them learn meaningfully and retain the learned materials unlike the traditional approach, which promoted individualized learning, perpetuated by the struggle to memorize for exams. According to them, meaningful learning implied learning for understanding rather than memorization of facts/ learned materials for the purpose of exams. Analysis of the interview responses revealed words, phrases, or sentences that showed students' appreciation of contextualized science learning, and particularly, how the approach was able to help them learn for understanding of the materials. Some of the phrases included: 'It has helped me to understand and remember things because I saw them', 'now you can recall easily because you saw it and did it', 'we can comfortably explain the procedure', 'it is not hard to remember', and, 'with this approach I do not need to memorize'. Other phrases included, 'initially it was hard to memorize different procedures', ' the procedure sticks with you', 'learning this way make things clear and real', 'doing it and seeing it has actually improved my memory', 'you write something that you already understand', 'how can you forget something that you wrote in your own words', and so on.

These students demonstrated their positive evaluation of the pedagogical model the present study was implementing, and implicitly, how they believed the approach was being supportive of learning compared to the traditional approach. Sifting through their views, one realizes that students were in a struggle between learning through memorization / cramming, and learning for understanding/ meaningful learning, and that through contextualized science learning, they seemed to have found a solution. Their views were elicited when asked to provide their general views regarding the approach, having gone through the program, including how it influenced their ways of learning. Maria and Jack, for instance, had this to say in response to this question:

> Maria: …for me…I find the approach perfect as it really helped me to remember things. …perhaps because we saw them and we had opportunity to compare/relate the materials with what we learned in class…You see…you could be asked, "With examples explain the procedures for processing and/or packing jam, tomato sauce or soya milk, or say powder soap? Or say, what are the components or the basic reactions involved in soap making? Initially you had to 'swallow' [cram/memorize] all the procedures…and it was hard…because we had done nothing practically. And, in fact, even if you are able to memorize, you would likely forget it during, or, as soon as you finish exams. However, with this [approach], you just recall easily because you saw it and did it. You learned it for understanding. Put it this way sir… before this project, we just knew things generally. For instance with soap, we knew in general, the raw materials required for soap making, and of course, just a few of

them…Now we know a variety of raw materials, and in this case, for making specific types of soap. We can comfortably explain the procedures…and some of the important combinations [reactions]. We can tell specific amounts of raw materials required to prepare a specific/particular type of soap, which we did not learn in class. In this way, when you are asked about this in exams it is not hard to remember, you will not need to think too much. Because you saw it, practiced it, and discussed it in class as well…[STD7: 680-693, November 19, 2013].

Figure 10: Soya milk processing: Students observing the required temperature

Jack: …In class for instance, we learned that when processing ‘matembele’ [sweet potato leaves] you just wash it and dry it in the sun…simple as that, and that is what everyone of us knew. However, that madam [at *Wajasiriamali* centre] showed it to us so nicely, and she was deeper in the procedure…She washed them gently in cold water, sorted out to remove the bad ones, put them aside for a while, then soaked them in hot water. She then added some salt, and finally sun-dried them. Then she would put them in an airtight container ready to store them for future use… learning through this way, make things clear, real, and exciting, and the procedure sticks with you. And for me, this is what makes this approach perfect. We did it with her. We tried things out…And for sure, we did not even need to read it anymore. You can explain it in many ways you like. You can just go home and do it confidently…this is because you saw and did it in a real situation [STD6: 572-583, November 19, 2013].

Figure 11: An artisan describing procedures for processing 'matembele'

Central to these students' views,is the message that seeing it and experiencing or practicing it made the whole contextualized science learning meaningful and relevant to them and to their learning needs. In their views, through this way of science learning, everything they learned remained with them, and they no longer required engaging in unnecessary memorization of facts. Rather, they learned for understanding. Recent studies on context-based learning, Walan and Mc Ewen (2017), and Walan and Rundgren (2015) pointed out how the use of context in the teaching and learning of the school science was of utmost importance in enhancing science learning, making it relevant, as well as giving students a sense of why they should learn the required materials/curriculum. Knowing the reasons why they are learning certain curriculum content, according to Gresalf et al. (2009), plays a vital role in increasing learner participation and involvement/engagement, which in turn, helps them to understand the materials thoroughly as well as be able to carry them forward into the new environment (c.f. Moje & Lewis, 2007; Stewart &Jordan, 2017).

Students in the present study revealed that through contextualized science curricular experiences, they were able to 'explain' and 'write things in their own words'. The learned material 'stuck with them' and they could do it 'confidently' and explain 'how it can be applied in different context'. Moje and Lewis (2007) considered these as the outcomes of meaningful learning. Eventually, when learning is associated with practicing or experiencing it, chances are that, students get the opportunity to see how the materials make sense to them, are relevant, and have use to their lives during and after school (Bround & Reiss, 2012; Hull, 1995). In the end, students become motivated to learn and achieve more because the learning materials are brought into concrete, actual experience, and memorable context (Lynch, 2002; Predmore, 2004; Walan & Rundgren, 2015).

Although framed in different ways, students' views demonstrated a sense of excitement about the approach and appreciation of the fact that this way of learning brought to them important shift in the ways they thought about and approached science learning. Responses from Daniel, Abdul, and Mwanaisha further illustrated this when they provided their post-experience views about the contextual science learning:

> Daniel: …in fact…seeing its practicality…the process of soap making, how the raw materials were measured and mixed locally, simply by *Wajasiriamali*, and in fact relating it with what we learned in class, made me to feel that this was the best way

that these topics were supposed to be taught. We could see every process at every stage of making various products, and more clearly than even what we had written in our notes. In fact, we could write all the procedures as they guided us through when doing it. I would even say that we came out with better notes than those we had written in our regular class notes books…I think doing it, plus making your own notes wouldn't make you forget it. ...I don't think we can forget the procedures or say for example, the substances [raw materials] that we were adding at every stage [STD1: 12-19, November 15, 2013].

Figure 12: Students enjoyed seeing, observing, and doing it while taking down some notes

Insisting on seeing and doing it, Abdul had the following to realize:

Abdul: …What I can say is that, this way of learning has made me not to easily forget what I learned. Because we saw and tried things out by ourselves, I still remember everything that we learned during the study visits. Initially, it was hard for me to memorize different procedures or steps for processing various types of food that we learned in class. You had to sometimes, devise acronyms for various steps in order to simplify memorization process. However, with this approach, you do not really need to memorize. You just have to 'close your eyes' and recall the way things were done and write it in your own words. [STD2: 192-196, November 15, 2013].

Figure 13: Getting general explanations on food processing

On the other hand, Mwanaisha saw the potential of the approach to improve learning because it gave them the opportunity to not only see and do things but also ask for and receive explanations, and construct their own summaries; something that was not available in their regular traditional classes. Furthermore, she acknowledged that extending science learning beyond the classroom made the science learning more meaningful, relevant, and exciting:

Mwanaisha: …In class you just copy from the chalkboard or from teacher's notes book. On the contrary, during field trips, you see, touch, and do things. You ask and they [*Wajasiriamali*] give explanations…then you write something that you already understand…and you write it in your own words. It's like you're making your own lesson notes. How can you forget something that you wrote by yourself? I found myself liking this approach very much…And you know what? Because they [teachers] organized us into groups, our group pays a drop-by visit to some of the *Wajasiriamali* around our homes, whenever we feel that we have something that we want to learn from them. We visit them, ask them questions, common ones and science oriented ones, and they give us answers. And, those which they can't respond to, we seek answers from our teacher…Through this method, I have come to learn that science is beyond classroom and that learning becomes more meaningful, relevant, and exciting when we relate what we learn in school with what we meet every day in our homes/real life environments [STD8: 283-287, November 19, 2013].

Figure 14: Observing, listening carefully and asking questions

Clearly, students' responses indicated the extent to which they were thrilled by the approach as it definitely resonated with their learning expectations. Having gone through contextualized science curricular experiences, Maria, for instance, seemed to acknowledge the approach while in some ways, criticize the traditional approach for the tendency to force them memorize facts, which they in fact, tended to forget as soon as they finished exams. In her view, connecting the school science with real-world experiences such as those done by *Wajasiriamali* helped them to learn better, than they learned in class based on traditional approaches. Together with her fellow students, Daniel, Jack, Abdul, and Mwanaisha, they appreciated the fact that seeing, experiencing, and practicing it in real world local context; including getting the opportunity to compare with what they learned in class, had a lot of impact on their memory and understanding. In general, the authentic nature of the *Wajasiriamali* learning activities that students in the present study engaged with seemed to make science learning relevant and appeared to be the reason that students positively endorsed the approach, because of its potential to support meaningful science learning compared to traditional approaches to science learning.

Perceptual dimension 3_2: *Ability to understand and explain various science ideas or concepts*

Students' post-experience evaluation of contextualized science learning revolved around the extent to which this way of science learning would support them in conceptual understanding. Having gone through the approach, their post-experience views/perceptions showed that the approach had the potential to help them deepen their understanding of concepts, including the application of these concepts in different settings. Their views highlighted the fact the approach gave them the opportunity to learn, recall, and connect science and math ideas or concepts they learned at school with the activities taking place in their everyday life environment. Also included was the opportunity to explore, test, or refine their conceptions in the real world, something which the traditional approach did not offer. Neema, Hamisa, and Jack, for instance, during their post-experience evaluation of the approach, revealed how through their participation in *Wajasiriamali* learning activities, they were able to learn, connect, and expand on their understanding of various science and math ideas/concepts:

> Neema: …Truly, you cannot compare this, with the 'old' approach…With this, you see things happening…you see some concepts being applied, and you get to learn more about them, although sometimes not so direct. You get to know ooh…this is why the teacher was telling us like that eee!…you get to connect what the teacher was saying in class with what you see right there. And this adds to your understanding [STD7: 452-455, November 19, 2013].

When she (Neema) was asked what conceptual connection did she recall, she had this to explain to the group:

> …I remember…there is a section that we visited, where we saw them [*Wajasiriamali*] applying the concepts of arc, circumference, radius, diameter etc in making such things as cooking pots, toasting pans, buckets, and poultry feeders. Although initially it was hard to relate, we slowly got some clues through observing what they were doing and how they were doing it, plus asking them questions, and eventually, we began to realize how some math concepts were being applied…although locally. …I can remember, for instance, the guy tied a piece of fiber/rope on a nail, and then measured a certain radius that would give the required diameter. Then holding at one point, he would draw a circle by using the nail on a flat metal sheet, cut it, and forge it into a pan of a particular size. It was such a local technique but fun and interesting. And in just a simple way, it put things into reality. I also recall, they used the concepts of arc and diameter in making irrigation bucket lids that open halfway…if

you know them. And, this was done by drawing and cutting a semicircle on a metal sheet and bends it in some ways to make a lid... Although they were not telling us everything, you could learn and see the application of various concepts, and you get an insight that, “aaha…so this is what happens-eee!?” I mean, if it was not these activities, may be, we would just have known that there is radius, diameter, circumference, but not how or where these could really be applied. Now, even if I make calculations involving these, I do it with the knowledge that ooh…this is how each of them translate to the other. I mean you do it with confidence that you know them well, you can explain or say something about them, and you know how they can be applied in some real life situations [STD7: 458-474, November 19, 2013].

Figure 15: Students observing some applications of math concepts

Figure 16: Application of math concepts in making frying/toasting pans

On the other hand, Hamisa had a lot to share in regard to chemistry concepts that she recalled to have connected during the study visits:

> Hamisa: …I remember in one of the study tours, our group visited Iron smelters and we saw them pumping oxygen into local furnace in order to produce high temperatures… required to heat metals to red-hot… And I recalled that we learned in class that oxygen supports combustion…i could connect something…When they had heated the metal bars/sheets to red hot, they hammered them to produce various equipment such as axes and machete and cooking utensils such as sauce- and frying pans. In this activity, I also recalled the concept of malleability. And here we saw how a piece of a metal could be changed, in its shape, without breaking. We learned this in class, as one of the physical properties of metals…I can say we also learned about conductivity of metals in this activity. While in heating the metals, some of them got red hot easily, others took longer time. For instance, iron sheets or bars would take more time to get red-hot compared to copper ones. Likewise, the

malleability of copper was high compared to that of iron. So, it was easy to change the shape of copper bars/sheets compared to iron…In this section, they were also making metal boxes from aluminum sheets. And they told us that they use galvanized sheets to prevent rusting. I remember they also told us that alternatively, they paint the boxes, again to prevent them from rusting. …so to me…these activities obviously, increased our knowledge of these concepts…No matter how small they were, they helped us to recall and connect with some ideas that we learned in class, and I think, this was important to us for learning [STD4: 47-57, November 15, 2013].

Figure 17: Forging tools at high temperatures using local furnace

Figure 18: Metalwork: Students receiving explanation on how metallic boxes are made

Figure 19: Teachers were also involved in providing clarifications

Similar to Hamisa, Jack connected some chemistry conceptions when participating in a soap making activity:

> Jack: …In terms of specific concepts, I would say, it's a lot. There is a lot to relate…I remember for example, in soap making trip, we saw acid-base reactions at play…we

saw buffer and buffer solutions and how they work, …you could hear people [fellow students] mentioning such terminologies as chemical equilibrium, endothermic reactions, exothermic reactions etc…all these in just one soap making activity. Actually, a lot of chemistry came in during soap making activities…yeah…most of these ideas/concepts came in when we were trying to maintain the pH of the liquid soap that we were making…where she [the artisan who was demonstrating to students] would sometimes ask us to use buffer solution to increase the pH, or add acid or alkaline solution to deal with it. …And interestingly, in adding these, the temperature of the soap solution would change, which indicated that there was an exothermic or endothermic reaction going on. I can also recall this idea of enthalpy and entropy change, although I cannot explain well...one thing is, we had not seen all these things happening in reality before. We had never gotten a chance to try them out in a real situation. They were all theoretical terminologies to us. Now I can say they are not! You can shout-them-out, and everyone knows what you are talking about. I mean everyone can have something to say about them, even though it may not be absolute correct…so, me I think, it is good to see things, to learn them in reality makes you understand…I mean, improves your understanding [STD6: 457-461, November 19, 2013].

Figure 20: Adding buffer solution to maintain pH in liquid soap making

Figure 21: Students testing to see if the soap that they made works

The three stories presented by Neema, Hamisa, and Jack, on the specific concepts they learned during *Wajasiriamali* study visits, demonstrated how useful the real world learning activities were for students to recall and connect with their prior knowledge, and in this case, with various concepts that they had learned previously in class. Particularly, the real world context in which this learning took place seemed to have played a major role in helping them to recall what they observed and learned during the visits, as seen in their confidence in explaining and giving examples of the events, activities, and concepts or ideas experienced during the visits.

As highlighted in the previous theme, according to the situated cognition perspective, a complementary perspective to the contextual learning theory, a domain of knowledge and skills is learned better when that learning occurs within the context where the knowledge or skill is used (Hull, 1995; Greeno, 1993; Lave, 1991). As such, it is highly likely that seeing how the concept is being applied in a real situation played a vital role in helping students 'explain' or 'say something ' about the concepts. This was important step in giving them confidence. They 'know it', as Neema stated.

4.3 Teacher views of the effect of students' contextualized science curricular experiences on their teaching

The second research question for the study aimed to investigate how students' contextualized science curricular experiences influenced/ or affected their teachers' teaching. Data on this question involved stories told by the six participating teachers during the focus group discussion interviews, on their experience with their students' contextualized science curricular experiences, and how this experience influenced/or affected their teaching. Since the teachers collaborated in modeling the experiences, where every contextual learning cycle/unit involved more than one teacher, it was appropriate to investigate the teacher-told stories through focus group discussion interviews because the teachers shared similar/ or related experiences. Morgan (1988) observes that it may take listening to opinions of others in a small and safe group setting before one forms an opinion or a thought. In the same line, Krueger (1988) pointed out that, one person's comment may trigger a response from another person, which would otherwise, not be heard if it was not triggered. In addition, Krueger (1988) asserts that, some participants feel more comfortable to answer in a group with similar interest because they want to feel that their comment is right before they air it out. Because an in-depth understanding of teachers' views on how their students' learning experiences impacted on their teaching as well as their interpretation of the impact was required, focus group discussion interview was found the most appropriate in the context of the present study.

That said, the focus group interview responses with teachers were transcribed verbatim, followed by a detailed analysis that involved examining, categorizing, and testing assertions for reliability (Grbich, 2013; LeCompte & Schensul 2010; Patton, 2000). This resulted into a thick description of the teacher interview data, containing their views about contextualized science learning, and how their students' experiences of the approach influenced their practices of science teaching. Data was then sifted-through to identify common patterns or themes demonstrating teacher revelations of how students' experiences with contextualized science learning influenced/affected their teaching. A thematic approach, thus, characterized the entire analysis, where, through the repeated listening of the interview video clips, review of transcript for the dataset, comparing and contrasting, categorization and re-categorization of evidence (Grbich, 2013; LeCompte & Schensul, 2010), three major themes responding to the second research question for the study emerged. These are presented and analyzed in the following subsections:

4.3.1 Conflict existed between teachers' effort to help students learn relevant and meaningful science and the nature and organization of syllabus/curriculum

Earlier in the background and elsewhere in the literature review, it was noted that curriculum in Tanzania is highly centralized and examination-driven (Hamilton, 2010; Osaki et al., 2002; Knamiller et al., 1995; Rugumamu, 2011). Furthermore, the curriculum has been criticized for its prescriptive nature that leaves little or no room for creativity and/or innovation in teaching and learning on the part of the teachers (Hamilton, 2010; Rugumamu, 2011). Because of the prescriptive nature and deeply examination-driven style, anything outside the syllabus requirements seems to be considered as not in favor of students' exam performance, especially in their final exams (Nashon, 2013, O-saki, O-saki, Hosea & Ottevanger, 2004). Moreover, because the tendency is to gauge teachers against the number of students who passed exams in their subject areas (O-saki et al., 2004; Hamilton, 2010), attempts to spend time engaging learners with activities that have no direct impact on their examinations is also likely to be considered a disservice. It is because of this, that during the examination of teachers' views on how their students experiences with contextualized science learning impacted on their teaching, teachers revealed that the nature of syllabus and the examination culture, acted as barriers against their efforts to help students learn relevant and meaningful science through this approach. Statements from the participating teachers -Tina, John, Fatuma and Christopher, demonstrated this:

> Tina: …You could see how the model was influencing our students…as we kept going, you could see their attitude changing…trying to learn by relating science with real things or phenomena…and you could see them feeling empowered…feeling that they have something to talk about… something to do after school, having learned from and…through *Wajasiriamali*… So… you kind of learn that perhaps, we were not doing just to them by teaching only the theoretical part of science…but again the

thing is, can we teach all the topics like this?...After this, we have continued to realize that there are topics, which could be nicely taught through this approach. Yet, like I said before, trying to organize the contextual learning lessons comes with it a question…to what extent is it worth doing it, especially when you know that the activities accompanying it may as well not directly appear in their exams... [TCH1: 140-152, December 4, 2013].

Tina: For sure, the approach interested all of us… let me say that we were teaching most of these topics just by explaining them plainly to our students… without any practical or hands-on activities…You wouldn't think about this… [because]…this is what the syllabus stipulates…classroom demonstration activities,…and the way it is overloaded makes you think twice before you put things together,. …However, after this project, which has actually opened us up, including our students, we have been devising some authentic hands-on activities with my fellow subject teacher... you can see it works so well…but in a way, it sometimes feels like we are doing it at our own risk… So eventually, you can be motivated to do something for your students, yet, that feeling that time is constraining, doesn't stop crossing your mind [TCH1: 7-14, December 4, 2013].

John: Before this project, I would rarely sit down and think of creating an activity outside the classroom... In fact, whenever you think of creating an activity, a lot of issues come around… time…the amount of content that you want to accomplish, students' preparedness to engage etc... Certainly, participating in this project has changed my mind to a large extent, and the way I see things. Now because students seem to be motivated, and you can see them that they want to do something, it is a matter of helping them to think of relevant activities for the subsequent classes…that is what I have kept trying to do. … And you can see them coming up with many interesting suggestions… you don't spend a lot of time to think about this. All you do is to give them hints, and they go, devise, and organize an activity, small activity, conduct it in their own time outside the class time, and come up with something to share with others in class. So my role then becomes more of moderating, so that the activity is not too big or too broad to consume much of their time [TCH3: 178-185, December 4, 2013].

Fatuma: ...it was so thrilling to realize how my students were inspired by what they learned from *Wajasiriamali*…for instance, during food processing and packaging study visit. You could see how authentic learning and learning environment influenced their motivation to work [learn]. …[however], to catch up with time and syllabus size issues, devising strategies to help them learn through this approach was the most important thing to me…yet, I had to choose the most relevant topics and have my students in groups organize and conduct some study visits to *Wajasiriamali* and prepare short presentations once a week to share with us from what they learned. And I was flexible in what they would like to do and present as long as it was real relevant. And they could present in any class that they felt relevant. I did not want them to feel pressured for no reasons…rather, do something good for learning, but also for their exams [TCH6: 313-322, December 4, 2013].

Christopher: …my students, for instance, showed a lot of interest in what was going to happen during a study visit to soap making *Wajasiriamali*…and I started to learn something…I could feel…that this was something that they were missing…because we just mentioned things. …so for me, all I did was to help them prepare questions to ask during the visit… and these were helpful because as they interacted with *Wajasiriamali*, you also learned something new, for the future classes… But back to school, after the in-class group activities and presentations, you could hear them, asking each other, and in fact, indirectly asking you… "We have learned so many things, you know…varieties of procedures and materials to make soaps and detergents; will all these come in the exams? I mean I wish they could ask questions from this!" …questions or comments like these, would tell you that like us [teachers], students were also somehow pressured by exams, or that they went to the contextual science learning lessons with some thoughts about exams. And that they would wish

> to see the time that they spent in the study visits being translated into their exams [TCH2: 336-347, December 4, 2013].

Although different, these teacher narrations indicated how at some point, they were constrained with time and examination pressures as they attempted to help their students learn science through the approach the study was presenting. Even though they were all fascinated by their students' contextual learning experiences, that is, the demonstrated interest, motivation, and readiness to learn science through this way, their stories reveal that syllabus bulkiness and urgency to help their students perform better in their exams were always on their minds as they attempted to organize science learning that draws on learners everyday local context.

In her explanations, Tina acknowledged she saw how her students were gradually changing their attitudes and begins to learn by relating science with real things. Because learning through *Wajasiriamali* involved authentic activities in which students also participated/ engaged in producing real products, her students felt empowered in the sense they believed that besides learning for academic purposes, they were also learning something useful for their lives after school. All these made Tina realize they were not being fair to their students by teaching science theoretically. Yet, in choosing what to do with her students in regard to this approach, she had to be cautious about whether or not it was worth doing in terms of time available and the value it would add to their exams.

Consistently, intrigued by his students' motivation to learn science through contextualized science learning approach, John declared to have acquired a changed mind. He devised a way that would not consume class time, helping his students think of relevant activity/activities for the subsequent lessons. Students would then organize the activities, conduct them in their own time outside class hours, and then share with their fellow students in class.

Bearing in mind the issue of syllabus size and time, John's role as he describes it, became more of moderating the activities, and in this case, to ensure that they did not consume a lot of time unnecessarily, "not too big, not too broad" activities.

Similarly, Fatuma adopted an approach closely related to John's. Having learned how the authentic learning environment motivated her students, she believed it was beneficial to devise strategies that would be time friendly to align with syllabus size. She went further than John and chose the most relevant topics to her, those which are likely to appear in the examination.

As for Christopher, similar to Tina, his students demonstrated interest and curiosity to learn science through this approach prompted him to reflect on his teaching approaches to realize his students believed they were missing something because they (teachers) 'just mentioned things'. Although he was not explicit, whether he had adopted a specific approach with his students as did Fatuma and John, he highlighted he would prepare questions to guide his students when interacting with *Wajasiriamali*. Even though Christopher's students liked and engaged well with the approach, they still would not let go of the question 'whether or not these things will come during exams'. In his view, this indicated that both teachers and student were in some ways subjected to examination pressures.

From these teacher-told stories, it is evident that while they were motivated and enthralled by their students' contextualized science learning experiences, the teachers remained in a situation where they had to choose to use this approach in their lessons. In addition to the benefits of contextualized science learning their students began to demonstrate, teachers found themselves in the middle of the struggle between helping students learn through this approach and the need to finish syllabus and help their students pass their exams. However, they opted to find time friendly strategies to help their students benefit from this approach to science learning, which they unanimously agreed that it challenged their traditional ways of science teaching.

4.3.2 The benefits that students derived from contextualized science learning had implications on how teachers interpreted and enacted the curriculum

This theme is closely related to the first theme. Despite the conflict that existed between teachers' effort to implement contextualized science learning and the nature and organization of curriculum/syllabus, teacher views during focus group discussion interviews demonstrated their students' contextualized science curricular experiences challenged their traditional ways of organizing, developing, and implementing the curriculum/syllabus. Particularly when their students began to embrace and demonstrate excitement and high interest in learning science through the approach. The efforts students showed demonstrated engagement with the lessons. The ways they interacted, asked, and responded to various questions posed to them during and after the contextualized science lessons, made teachers to rethink their traditional ways of organizing and conducting their lessons. Even the weak students demonstrated engagement with and participated and contributed to the learning, teachers felt obliged to encourage and support their students' learning Responses from the participating teachers, Alice, John, Tina, and Christopher, when asked to explain how did they think their students' contextualized science learning experiences influenced their classroom practices, demonstrated this:

> Alice: …You see…it is interesting the way students responded during the study visits. Their urge and passion to ask questions, and in fact, relevant questions, was beyond my thinking… even if it was you, it would automatically challenge the way you do things. I mean the way you prepare and conduct your lessons. See for example, what I used to do before was to just review my lesson notes, prepare the

outlines/the plan summary, and get myself ready for the class… now days it is different. You find yourself having a bit more things to do…especially when there is no group volunteering to present a contextual learning experience. You go back to syllabus, see if there is any proposed activity, and organize it while incorporating something to reflect their real life experience. At least have that component in the activity. If there isn't proposed activity in the syllabus, you make sure that you develop an activity or something related, to share with them. Something that connects with their real world experiences…plus you get ready to be asked and answer questions. …in short, the approach has made us get real engaged with the syllabus, and the lessons unlike the way it used to be before… [TCH5: 167-175, December 4, 2013].

John: …for me, let me start by saying…I have realized that students feel better when they recognize that what they learn in class does not end up in books, papers, or exams, rather, it happens and has application in their everyday lives. When they have realized this, you can see them learning passionately, enjoying it, and putting a little more effort that before. You can real see them engaged with learning, doing things, making things, and they are happy with it ...yes, some questions may emerge here and there as to whether 'these things will be asked in exams', however, you can see that the model has helped them realize that learning is more than getting the grades, rather, it's about understanding things and learn how to apply them in their everyday lives. To me, these are what I see as benefits of this approach that we cannot deny them [the students]…and I should say that they have influenced the way I look at syllabus as I get prepared for my lessons. Despite all the challenges that we are facing [he mentioned later - long and strict syllabus, and a lot of testing and exams, weekly and monthly tests], you wouldn't want to take them [students] back to where we came from. [TCH3: 26-36, December 4, 2013].

Tina: …me too…just like what Alice just said, I find myself, at the end of the day, drawing my lessons in somewhat different way. …for example, even when I don't have *Wajasiriamali* study trip or presentation with my students, I come to class prepared to connect my lesson with anything relevant, even if it is not stated in the syllabus…anything that goes on outside the class. …because now days they[students] come prepared to here or learn if there is any connection that will happen…so it is interesting…so far the learning atmosphere has changed to a large extent. …sometimes even when the syllabus is telling you to do it this way, you kind of tilt it slightly or add up something, just to make sure that you bring some things that students can connect…can make connection…because they want to see it…and in fact if absent, you may expect questions about connections. That is how it is now days [TCH1: 180-189, December 4, 2013].

Christopher: … because they [students] discuss with me before making presentations related to *Wajasiriamali*, I have to prepare some relevant questions that link what is in the syllabus with what will be going on in their presentations, though more questions use to emerge during presentations. …After they have presented, I open up the discussion and students follow the same way, asking questions in search for connections with some ideas or concepts in the syllabus. These things were not there before. It works so well though. And in order to encourage this, in my weekly or monthly tests, I always put a few questions connecting between what we learn in class with what's done by *Wajasiriamali* just to encourage them learn more, and learn to connect. I wish same was done in their final exams. Bringing even a few such questions in their final exams would encourage them to learn more about and through this way. And it would help us to confidently interpret and teach this way even without changing the curriculum…because we wouldn't fear of misusing the time. [TCH2: 229-240, December 4, 2013].

It is clear the teachers' views demonstrated the way students responded to the model and found learning opportunity/benefits that stimulated teachers transformation in their thinking and the ways they approached the syllabus and carried out instructions. Every teacher talked about helping students to make connections and link school science with their everyday life experiences, terminology not heard during the beginning of the study. Alice, for instance, declared to be engaged with the syllabus unlike 'the way it used to be before'. In her view, she was motivated that students were enthusiastic about learning through this way, and she did not want to discourage them:

> Fatuma: "It is a new challenge but by any means, it has changed learning into an active engaging business. …You can see every student engaged in thinking about connections between what we discuss in class with what's happening in their homes [local environments]…a lot of questions directed to this, or those with this orientation… so you want to encourage this by making sure that you do not go to class without anything related to this" [TCH5: 207-211, December 4, 2013].

On the other hand, Tina's students were coming to class prepared to make connections between the lesson and what is happening in their everyday local environments. In her case, she changed the way she drew her lessons from the syllabus to ensure she brought real life experiences to her class even if not stipulated in the syllabus. In other words, she had to push herself to go beyond the syllabus, just to make sure her students learned some relevance in her lessons.

Likewise, John seemed to be explicit about the benefits his students realized from learning science through contextualized science curricular experiences that moved and influenced him. His students' realization that learning in classroom does not end there and is not all about exams; rather, how learning could be applied to their everyday life environment, made him realize it was not right to deny students the opportunity to learn science this way. As such he did not want to take his students back to the old ways.

Christopher, a chemistry teacher concerned with students' questions about whether or not 'this will be asked in the exams' used question style to guide his students to search for connections between various science ideas or concepts in the school science and the real world, something he did not do before. He also included questions in his weekly/monthly tests, just to encourage students towards this type of science learning. His wished to see examinations incorporating questions related to ‘these’ kind of students’ real world experiences to encourage them interpret the syllabus without the fear of ‘wasting time’ for nothing.

Clearly, students’ positive responses towards contextualized science curricular experiences had much to do with how teachers responded to the approach. Their grasp of the central theme of the model and the way in which they embraced it, induced the urge for teachers to change in the way they viewed teaching and interpreted and enacted the syllabus/curriculum.

4.3.3 Contextualized science curricular experiences enhanced collaborative teaching and learning among the teachers and the students

Based on their stories about their experiences with contextualized science learning, teachers acknowledged that the approach stimulated collaborative teaching and learning among themselves as well as their students. As they stated, unlike the way ‘it used to be’, the mode of organization and implementation of contextualized science curricular experiences brought them together, and their students as well. Hence reducing the commonly observed social distance among themselves, between them and their students, and among the students. Teachers acknowledged to have seen collaboration improving among themselves. They were now involving each other, for instance, in identifying relevant topics from the syllabus; interpreting, developing, and executing the selected lessons based on contextual learning approach, including inviting each other in their classes when they had students presenting the *Wajasiriamali* or related learning activities. Teachers acknowledged their students' experiences with contextualized science curricular experiences, transformed them from being mere student-receivers to engaged-learners who were enthusiastically ready to participate in the preparation and execution of their own learning, and this encouraged collaboration among themselves and the teachers. Excerpts below from teacher narratives explain this further:

> John: …you see…even when we had group activities in class, it is me who dictated what to do and in fact, how to do it. However, now I simply involve them [students] in identifying the areas, or say, ideas or concepts that link with their everyday life phenomena or activities. It goes easy and they just like to be involved. In fact, when I involve them in identifying and planning for an activity, its implementation becomes even easier…and you can see them happy to participate or engage….and you can see that they also learn how to plan and manage their own learning… It actually makes you think that this is what we would want them to be… [TCH3: 73-82, December 4, 2013].

> Alice: …I am also noticing that they [students] are now asking questions to each other during class discussions, different from what it used to be before, where most of classroom discussion questions would be directed to me and it was me responsible to involve other students in responding to the questions. The *Wajasiriamali*-classroom learning activities acted as center for discussion, for instance, in exploring science concepts and ideas, and making connections. I want to think that the approach has impacted on the classroom culture and social relations. My students…in my class for instance, are now very close to one another and to me as well. And the interesting thing is that, you don't see them really choosing who they want to discuss or work with, like it used to be. I am so much impressed by this. Group formulation is now easy, and you can see that the distance between them, the social distance, has been reduced to a large extent. They are now talking to each other more freely during class discussions. Not like in the past, when it was them talking to me or me to them most of the time during the lesson… I think the interaction that they made during

Wajasiriamali study visits pulled them closer and made them to like/enjoy working together… I am optimistic that this is going to have impact on their learning [TCH5: 85-101, December 4, 2013].

Agness: ...just as John said, I don't think alone when it comes to activities. I just open up, then we think together, and come up with something they can go observe in their own time and come to share with us [TCH4: 117-127, December 4, 2013].

Fatuma: …As I said before, now I don't just go prepare my lesson plans and set instructional objectives…I look back to see what, if any, will my students learn, that has some direct application in their everyday lives. I involve them in bringing up the phenomena, situations, examples, or activities that relate to the forthcoming topic. This way, I indirectly, get my students prepared for the next lesson. Previously, students would come to class, just to wait for what I would bring in. However, in the recent, you can see them bringing things from their experiences, that they are eager to share with others in class. It is really interesting, and you feel so much delighted when you realize that your students are ready to engage with a lesson in some new ways [TCH6: 260-268, December 4, 2013].

With respect to teacher collaborations, John and Agness had this to say,

John: …I don't remember the last time I sat with my colleague in the department let along my subject colleague, to discuss matters related to teaching and learning. With exceptions of collecting lesson plan and logbooks or submitting and discussing examination results, I have no clue if these things ever happened before in our department (He meant teacher collaboration in planning and implementing teaching and learning strategies). See now we are able to sit together and discuss strategies to teach some topics, share experiences of teaching various topics, and even suggest and try out new strategies. Sometimes we also visit each other's class when they have *Wajasiriamali* class presentations…for sure the approach has brought us together as science teachers [TCH3: 186-194, December 4, 2013].

> Agness: …yeah, sure…the approach has brought up some spirit of teamwork. Now days, when we are in the department [she meant department office] you can hear teachers sharing or exchanging some ideas on how to take care of some topics or concepts, especially those that they want to try out with contextual learning approach. Sometimes we go as far as helping each other to identify relevant places that students can go. And this makes it easy when you go to class to discuss it with your students. Sometimes we also invite each other, during class presentations, if someone has time. And for sure, they don't just come to sit and listen. They learn something and contribute to the discussion as well…you can sense that everyone finds it fun and interesting, and so, no one would want to miss it when they have time…So, I would say, in some way, the approach has really brought us together…It is encouraging seeing us working as a team of science teachers [TCH4: 134-141, December 4, 2013].

As per these teacher narratives, contextualized science curricular experiences appeared to transform the learning environment into a mutual collaborative one, unlike in the past where teachers worked individually in a teacher-centered teaching and learning environment. It was noted during implementation of the study that participating teachers believed it was appropriate to involve more than one teacher when conducting a contextual learning study visit. Gradually, teachers immersed themselves into the style, where everyone would invite the others when conducting a contextualized science learning study visit with their respective classes. Implicitly then, this science learning approach seemed to have brought teachers closer together, and increased interaction among them. Consequently, the teachers collaborated with each other, not only in the implementation stage but also in the lesson planning and organization stages.

4.4 Factors that prevent teachers from utilizing the contextually based mediations in the teaching and learning of the school science

The final research question for the study intended to explore factors in the current high school science teaching and learning in Tanzania that prevent teachers from employing and utilizing contextually based mediations in the teaching and learning of the school science and ways the problem could be addressed. While some responses to this research question were sought through asking teachers and students direct questions regarding the factors/ the reasons, other responses emerged as teachers and students attempted to share their stories about their experiences with contextualized science learning approach that the present study was implementing, including the associated challenges.

Based on my own lived experiences, the knowledge of the context in which this study was conducted, and what other available studies observed, I went into the research with several hypotheses about this question. I envisaged the factors could include among other things: the associated cost that might be involved in organizing the contextualized science learning; teachers' willingness to engage with this type/approach to science learning, especially because of their big/crowded classrooms; and, community readiness (in this case the *Wajasiriamali* artisans) to engage with learners in their local contexts (c.f. Bennett et al., 2005; Kasanda et al., 2005). Nonetheless, this was not the case with the research results. None of the teachers or students involved in the study mentioned the problem of the potential cost involved in executing the approach. Observation and actual experience learned during the research showed *Wajasiriamali* and many other related context-based learning places near the schools and around students' home neighborhoods provided opportunities for students to visit, learn, and connect with the school science without incurring significant extra costs. Furthermore, as results in the previous sections indicated, teachers and students in the present study were very positive and supportive of the approach. And to them, the advantages that the contextualized science learning came with outweighed the challenges that might be involved. Yet, the local communities, and in particular, the *Wajasiriamali* artisans, who were the main focal point of the present study, provided the highest level of cooperation, and were very much enthusiastic about students visiting them for learning, which made the 'community readiness to cooperate', not a problem at all. Thus, a careful analysis of teacher and students responses to this research question showed that teachers and students were not making use of the contextually based mediations in the teaching and learning of the school science due to three major reasons: (1) the nature of curriculum itself and the curriculum content; (2) prior teacher training and schooling, and; (3) mode of evaluation of the curriculum.

4.4.1 The nature of curriculum and curriculum content

Teachers were of the view that the curriculum was too centralized and prescriptive and offered teachers too narrow a space to enact and support students learning based on what is available in their everyday life local contexts. According to their views, the syllabus did not provide opportunity to create real world hands-on learning activities to help learners connect what they learn in class with what they encounter in their everyday life local environments. Teachers also expressed concerns that some topics were too disconnected from the learners' lives while the content had many aspects not available within the immediate environment of the learners. Three of the participating teachers, Fatuma, Alice, and Christopher commented about this:

> Fatuma: …As we said before, the syllabus is too prescriptive. Everything is pre-determined. …and they will examine students along those lines…so to teach outside

the syllabus when you know exactly that student will not be examined in those aspects or in ways that you teach them, can be tricky… [TCH6: 423-426, December 4, 2013].

Alice: There are a lot of abstract issues in science. Some of them, because of the way they are presented in the syllabus, and hence, taught in class, are viewed as being very complex and without immediate connection with what is happening in learners' local environment. …because of that, simple concepts, at the end of the day, are felt by students as being very complex and abstract…so perhaps syllabus review would help... to include what learners experience in their everyday world…and I think this will not cost anything… Or they need to suggest for us what to do to help learners connect with their real world, say in their homes, especially given that the current syllabus is considered a competency based syllabus …and in fact, to make science learning live and real…There is a lot that we can do you know! only that sometimes you feel like you don't want to waste time….Yes, we can do some of the things by ourselves, like what this project has opened up to us... However, when you know that you are not going to be able to finish syllabus, and yet, they are not going to be evaluated in that, it makes you think twice… [TCH5: 475-486, December 4, 2013].

Christopher: …there is a need to be flexible. Our syllabus needs to be flexible, in terms of allowing teachers to choose things based on the context in which they are…choosing how to teach some of the things…including the materials, strategies, and resources to use in order to make science learning easy and possible…and relevant as well. This way, our modes of evaluation of curriculum, including the nature of our exams needs to be modified to incorporate the 'relevance thing' that this approach is bringing, so to encourage learners to be creative and learn things from their context. …You see, it is surprising that the new curriculum is dubbed as 'competence-based curriculum'…They call it competence-based curriculum, which intends to build skills or various competences to students. Yet, you wonder, how can you help students develop competence by just bringing a sample of the learning materials or models in class? Some of which cannot even be brought to class…Or,

> how can you build competences by just mentioning examples in class? …So I just think, in order to harness the benefits that this model is bringing, which seems to be very much relevant with what the new curriculum is advocating , time estimates in the syllabus should consider inclusion of hands-on real-life learning activities in order to help us help the learners do real science rather than just hearing about it. [TCH2: 488-502, December 4, 2013].

The students responses were not far from their teachers' views. With the exception of giving examples in class drawn from their local contexts, they expressed concerns that no real world experiences such as those they experienced with *Wajasiriamali* were involved in science learning in their classes. Most of them blamed the rigidity of syllabus, and noted it did not guide teachers towards using 'this kind of teaching-learning approach':

> Jack: Teachers are very much guided by syllabus. They will always teach according to syllabus. So if there is no mention of study tours in the topics, I don't think they can plan or organize one….Teachers like to follow syllabus …because everyone wants to finish [the syllabus] before exams…Everyone keeps struggling to make sure that their students pass exams… that they do not miss a question because of the reason that they were not taught…because they know that they will be blamed! [STD3: 338-343, November 15, 2013].

> Felix: …even if teachers would like to teach this way, the curriculum does not tell them to do so… If you look at the syllabus, everything is written, how they should do it, including the number of periods, and hours required to be spent in each topic and so on. …This means that if the thing is not indicated there, they will not do it…I think teachers will need to generate extra hours in order to teach like this, which is what I think, makes it more difficult [STD6: 616-620, November 19, 2013].

Reading-through the comments, both teachers and students seemed to have concerns about the rigidity of the syllabus. A further discussion with teachers outside the formal interview, guided by one O'level syllabus for the biology revealed what teachers were required to do in class was very much prescribed. The teaching and learning strategies for particular topics or subtopics were proposed, teaching and learning resources outlined, lesson organization stipulated, guidelines for assessment specified, and number of periods and time allotted. Given this syllabus structure, organization, and 'bulkiness', it would be difficult for teachers to not do what the syllabi required; although, this study's introduction of contextual learning project seemed to have unleashed some possibilities.

4.4.2 Prior teacher preparation and schooling

A plethora of literature states that teachers teach the way they were taught (Blanton et al, 2003; Chicoine, 2004; Karmas, 2011; Nashon, 2005; McQuiggan, 2012; Short, 1993; Thomson et al., 2002). Yet, other literature presents conflicting results showing that beyond their previous experiences, teachers draw on a range of sources to build and shape their classroom practices (Carter, 1997; Cox, 2014; Elbert-May et al., 2011; Frankson et al., 2003; Oleson, 2014). Such sources include beliefs about teaching, instructional goals, features of an organization such as culture and contexts, as well the mission and vision statements of an organization (Oleson, 2014). Based on their views, teachers in the present study demonstrated that even though they supported the contextualized science learning, their interpretation and enactment of the syllabus based on this approach was still influenced by how they were taught and prepared as teachers. Although students' experiences with this approach seemed to have largely influenced how they embraced the approach, they seemed to retain the ways they were brought up as students and as teachers. In sharing their views about the approach, particularly the challenges they encountered during implementation of the present study, teachers had this to say:

John: …let me say that…to decide to use this model is to rest assured that you will receive a lot of challenging questions outside the syllabus. For instance, in the case of this project, when students did not connect well with the explanations that they received from the *Wajasiriamali* artisans. ... In fact, it is as well, to be ready to receive questions from the artisans too. … so if things go tough, that feeling that you want to take care of everything by yourself comes in…so you find yourself, kind of…you know… 'Better the old approach'…the old way of doing things. Because you think perhaps, it is the easiest way of doing things…no one bothers you. …that kind of feelings...The fact that we were not brought up in, and with this kind of learning, those are some of the challenges… [TCH3: 325-334, December 4, 2013].

Agness: …for me, I would say the challenges that we have been encountering, as far as this method and other related methods are concerned, could be associated with two things: our individual backgrounds as teachers, and the school environment itself. See for instance, personally, I did my teacher training in a private teacher college. We had no sufficient books, no laboratories, no practical activities, not even study visits like these. Everything was done theoretically. Even the practical activities were done theoretically, where they would give you data to calculate/estimate things like volumes, concentrations, atomic weights etc…So…plus the nature of syllabus itself, doing things like hands-on or real-life learning activities is not something that would come to you so quickly. Likewise, the environment that we grew up was not in favor of these kinds of teaching… every teacher was interested in exams…making sure that students were able to pass their exams…because that is where their pride was, so do we!...because we are in the same environment….and things have not changed so much [TCH4: 345-356, December 4, 2013].

Tina: There is a problem of attitude and perception. We could do a lot of things without much use of extra time or cost. Some topics could involve taking students outside the classroom within the school campus. This would not take much time or money, if you like. Yet, no one had ever thought about this. We have school gardens and flower beds to teach about plants; we have school water supply and drainage systems to teach about water and pollution; we have a small workshop center where some physics topics could be brought into reality beyond classroom or laboratory walls…A lot of *Wajasiriamali* artisans reside only a walking distance from the school fence. Yet, we give little or no thought about this. Perhaps this is because; this is not the way we were brought up as teachers. If there is anything that could be done, with no big efforts to make science learning active and meaningful, I think this model has opened us up… [TCH1: 402-411, December 4, 2013].

> Christopher: …adding to what Agness just said, I too, do not remember in my two years at Diploma College, to have attended any field trip for the learning purposes, let alone the recreational purposes. We were used to being in class, class, class! Everything was done in class. Even the leaner-centered methods that were insisted, they still taught us theoretically in class. Just sitting there…and listen…listening about participatory methods!. So you can imagine this type of background…you kind of end up thinking perhaps this is the best way to teach…so when this project came in, it was obviously a challenge to our orthodox. …and I should say, what actually came into my mind the first time I heard about this project, was, how will it fit with our routine/regular teaching strategies. …so… you are implementing the approach and actually, you have known and seen the benefits of it, but still, at some point, situations come, that make you think that the traditional teacher-lead teaching is still needed…that kind of…hangover… [TCH2: 425-435, December 4, 2013].

Although from different angles, all four teachers seemed to associate, in some ways, their schooling and college background with the challenges encountered in adopting or incorporating contextualized science learning experiences in their teaching. Agnes, for instance, shared her background, which apparently, did not give her the opportunity to experience hands-on real-life learning activities. In her view, this is one of the reasons that hands-on real life related learning activities would not come quickly, as she chose her day-to-day teaching-learning strategies. As for Tina, though she declared plenty of ways in which science could be taught beyond the classroom walls with no cost, she was also of the view that perhaps it was because teacher training did not provide ‘these’ type of teaching and learning experiences. She seemed to indirectly, connect this with the low motivation and interest to adopt or incorporate this type of learning in their classes. On the other hand, while Christopher was more explicit in identifying the traditional teaching and learning background as the main hindrance in their attempt to adopt the contextual learning in their day-to-day science teaching, John was of the view their schooling background made them to think that the traditional teacher-led teaching was the best.

4.4.3 Mode of assessment/evaluation

Mode of assessment is another concern teachers felt deterred their efforts to incorporate contextual learning in their day-to-day science teaching. Accordingly, teachers were of the view that despite the revised curriculum being a ‘competence-based curriculum’, advocating the development of knowledge and skills in various aspects of science, the mode of evaluation remained paper and pencil, which emphasized more on the assessment of knowledge of concepts and principles and less on the assessment of real world skills and conceptual applications. Even though the main objective was made explicit in all science syllabi, that is, to ensure that at the end of each course, students are able to “make appropriate use of the knowledge and skills gained in solving various problems in daily life” (URT, 1995, 2015), little was assessed during exams that related to the real-world application of concepts and principles in students’ everyday lives. In other words, teachers believed the examinations were too theoretical, focusing more on testing memorization of facts and principles, and less on application of the theoretical knowledge obtained solving real world problems. Something teachers thought would encourage the use of local context in the teaching and learning of the school science. Consequently, they felt the rigidity of the syllabi, plus the examination format, including the nature of questions, left them contemplating whether or not, and to what extent they should incorporate aspects of contextual learning. Especially when they knew exactly ‘these things’ would not be included/tested during final exams:

> Alice: There is a problem with evaluation. Our exams are totally paper and pencil. We do not evaluate our students through observation. We don’t evaluate skills. So obviously, it is easy for one to ask, why should I bother about hands-on activities, hands-on skills, which will actually, not be evaluated? Which will not contribute to my students’ final examination grades?…such questions! For example, yes, we enjoyed teaching through this approach. And we actually saw how it made students active learners, unlike the previous approach, but you know…those are the common questions…will this contribute to my students’ final grade? [TCH5: 416-422, December 4, 2013].

> Agness: …look at the type of questions they ask, or the answers that they demand…I don’t think they are trying to measure skills…or competence as they advocate…I mean the application of classroom knowledge into a real practice. Most of questions relate to conceptual knowledge, principles, and procedures, requiring students to recall things, explain, identify, outline, name, mention, define etc. And actually…recalling or identifying things that they read from books…a mere recall from memorization… In a situation like that, it is hard to expect us to get out of books, out of the class, to look for something actual, something relevant, something…which you think they can do to promote further understanding and application. ….So before this project, even if you stretched yourself, you ended up asking students to just bring examples, relevant to their context…and that was it [TCH4: 475-484, December 4, 2013].

> John: …Yes, contextualized science learning is not all about the skills that students obtain through this approach. We know it is also about helping them to easily

> understand the concepts, as well as its real world application. Yet…and this is on the part of students, they will not concentrate or take this type of learning seriously, if they do not seem to see that the things that they learn through this approach are examined. Put it this way, if we take them through the entire contextual learning cycle, and yet they are asked to mention items, to define, list, identify, etc rather than say, use the formula…, explain how to make…, demonstrate… show how… and in this case, such things as those done by *Wajasiriamali*, they will consider the contextual learning of little or no use …or they will not differentiate it from the old traditional approach, and this can just be discouraging [TCH3: 454-462, December 4, 2013].

The teachers' comments above seem to clearly link the nature of exams with the reasons for non-inclusion of contextualized science curricular experiences in their day-to-day science teaching. Reading the comments carefully, one realizes that teachers were in the middle of appreciating the contextualized science learning, while at the same time, negotiating their students' needs as well as the curriculum requirements, as they attempted to implement this approach to science learning. These results are not very far from what other related studies found. A systematic analysis study by Bennett et al. (2005); a contextualized science learning study by Nashon (2013), and a study by De Jong (2006) on conditions necessary for successful implementation of context-based learning, all identified that mode of assessment and evaluation have a significant influence on how both teachers and students would embrace and adopt context based and related science learning strategies.

4.5 Chapter summary

In this chapter, I analyzed the key findings on how students and teachers viewed and /or perceived the implementation of contextualized science curricular experiences, a science learning approach that involved a combination of both classroom and out of classroom real life learning activities drawn from learners' everyday local environment. The aim was to interpret the views or perceptions in ways that demonstrated how both students and teachers believed this approach would influence learning and achievement in science on the part of students, but also, the instructional practices on the part of teachers. The study data was collected from both students and teachers and involved: pre- and post-experience questionnaire and focus group discussion interviews with students; post-experience focus group discussion interviews with teachers; and researcher's field notes. While the school science content was drawn from the mandated science curriculum, real-world learning experiences were drawn from *Wajasiriamali* manufacturing and processing artisanal groups, located near the school and students' home neighborhoods.

Results indicated that prior to implementation of the study, students' evaluation of the effect of this approach to science learning revolved around three major areas/themes namely: (1) relevance and use of the pedagogical model; (2) nature of syllabus in relation to time; and, (3) fear of learning non-examinable science content. However, post-experience results revealed the suppression of the third pre-experience theme, with the emergence of a new theme namely, ability to understand, explain and apply various science ideas or concepts.

As for the second research question, the study aimed to investigate what effects would students' success in learning science through this approach have, on their teachers' teaching. Emergent from the analysis of focus group discussion interviews with teachers were three themes that responded to this research question. First, the analysis revealed the approach elicited in teachers, motivation and interest to help students learn relevant and meaningful science. However, their efforts to help students learn through this way, conflicted with the nature and organization of syllabus. Second, results indicated the benefits students derived from learning science this way had implications on how teachers interpreted and enacted the curriculum. In other words, students' experience with contextualized science curricular experiences challenged teachers' status quo (their traditional ways of developing, organizing, and implementing lessons), and in response they began to devise different ways in which to incorporate elements of the contextual science learning in their lessons. Lastly, the study found contextualized science learning acted as a catalyst that enhanced collaborative teaching and learning among teachers and students which according to both teachers and students was not there previously.

Finally, the study examined reasons why teachers did not prefer to use contextually-based mediations in their every day science teaching. Three major reasons were identified: (1) the centralized, overloaded, and rigid and strict nature of syllabus; (2) prior teacher preparation and schooling background; and (3) dominant traditional paper and pencil mode of assessment and evaluation of students which focused on the assessment of knowledge of facts and principles with non-inclusion of the skills and applications.

Data analysis in this chapter incorporated some initial discussion of these results. The following chapter extends this discussion to further relate and link the results with the theoretical and other empirical evidence available in the literature.

Chapter 5: Discussion and conclusion

This chapter presents a discussion of findings resulting from the study's data analysis which investigated how contextualized science curricular experiences influenced students' learning, which in turn, affected their teachers' teaching in Tanzania. The study intended to answer three research sub-questions namely: *How do Tanzanian high school students experience science learning in a science unit that integrates both classroom and out-of-classroom real life learning activities? How does student success in this way of science learning influence/affect their teachers' teaching?* And, *what factors in the current high school science teaching and learning in Tanzania prevent teachers from employing and utilizing contextually based mediations in the teaching and learning of the school science and how these could better be addressed?*

In this chapter, the theoretical framework and relevant literature review discussed in Chapter Two are drawn upon in order to extend the introductory discussion that was offered during data analysis. Through a deductive approach, the chapter draws upon the sociocultural and contextual learning theories as well as expectancy value theory of achievement motivation to support the data collected for the study. While sociocultural theory informs the individual as well as social aspects of learning, the contextual learning theory informs the roles learners' everyday local environment/ or context has, in enhancing science learning. Yet, the expectancy value theory of achievement motivation supports/explains students' reaction/responses to the learning innovation the present study was introducing. Eventually, the three theories taken together provided an interpretive lens to understand the data collected for the study.

Thus, the chapter elaborates on: the pre- and post experience student views/perceptions of the effect of contextualized science curricular experiences on their own learning in science;

teacher views of how student success in learning science through this approach influenced/affected their practices of high school science teaching; and finally, factors preventing teachers from employing and utilizing contextually based mediations in their day-to-day science teaching. This discussion of findings lays an important foundation to understand the role the incorporation of real-world learning activities drawn from learners' everyday life local environment has in creating relevance, and improving school science learning and teaching, in addition to the role in supporting the recent move in Tanzania to promote the growing middle-level industrial sector, commonly known as *Wajasiriamali*.

5.1 Research sub-question 1: How do Tanzanian high school students experience science learning in a science unit that integrates both classroom and out-of-classroom real life learning activities?

5.1.1 Students' pre-experience views/ perceptions of the effect of contextualized science curricular experiences

This research study intended to bring learning innovation to classrooms for the purpose of improving learning. According to Serdyukov (2017), an innovation in education refers to anything introduced to classroom for the purpose of improving effectiveness and efficiency in learning. It could be "a new pedagogical theory, methodological approach, teaching technique, instructional tool, learning process, or instructional structure, that when implemented, produces a significant change in teaching and learning, which leads to better students learning" (Serdyukov, 2017, p. 8). It is for this reason that understanding student initial views/perceptions towards the approach that the present study was introducing, was deemed necessary, as it would help revisiting the approach including its organization and implementation procedures before the beginning of the study, for the better results. Studies in teaching and learning innovation suggest when implementing classroom innovations, attention should be given to potential sources of negative perceptions as well as active listening and responding to students concerns at the outset if a successful implementation is to take a route (Dembo & Seli, 2004; Keeney-Kennicutt, Gurnersel, & Simpson, 2008; Tharayil et al., 2018). The study's pre-experience survey and focus group discussion interviews were important as they acted as a basis on which to get students involved in planning, organizing, and suggesting their own learning, thus, become part of the innovation rather than mere strangers as Kwek (2011) suggested (see also Nisbet & Collins, 1978). At the same time, this study took the form of an intervention where the learning approach was introduced to students and practiced, for the purpose of examining how it would work in that particular context. Thus, knowing their initial views/ perceptions was considered important as it would help ascertaining the impact/effect this approach would have on students' learning, towards the end of the study.

That said, results obtained through pre-experience questionnaire and focus group discussion interviews showed that, even before implementation of the study, students had knowledge of the existence of the relationship between school science and activities by *Wajasiriamali,* and how these activities could potentially be useful in supporting school science learning outside the classroom. The students acknowledged and supported the approach and believed it was going to make a difference. It would create spaces for meaningful learning, which for the students meant learning for understanding rather than memorization of facts to be reproduced during exams, as with the traditional approach to science learning. However, because it was the first time that students had encountered this way of science learning, their initial evaluation of the approach, prior to implementation of the study, came along with skepticism and/or concerns. Their thoughts regarding the approach revolved around three major areas/themes, namely: (1) relevance and use of the pedagogical model; (2) nature of syllabus in relation to time; and, (3) fear of learning non-examinable science content. In other words, while acknowledging the approach prior to implementation of the study, students evaluated contextualized science curricular experiences as a useful way of learning the school science, except that they raised some concerns regarding the approach, which revolved around the three major themes mentioned above.

The literature, however, indicates that student skepticism regarding classroom innovations and particularly learning innovations is not a new phenomenon (Charles & Issifu, 2015; Johnson, 1965; Kwek, 2011; Nisbet & Collins, 1978; Seidel & Tanner, 2013; Tomasetto, 2003). Kwek (2011) and Nisbet and Collins (1978), posit that in the context of a new classroom innovation, students will tend to question, choose what to do, make decisions, attempt, and sometimes refuse, based on what it seems to work for them and benefit or make their learning life simple yet productive (c.f. Towndrow, Koh, & Soon, 2008). Yet, according to the expectancy value theory of achievement motivation, students' choice to persist in learning activities is highly dependent upon their expectations for success as well as their personal values regarding the activities (Eccles et al., 1983; Wigfield & Eccles, 2005). Their engagement with learning tasks or activities is highly determined by their perceived expectations that the activities will have particular consequences in their learning, as well as the degree to which the effect of these consequences/ outcomes will be positive (Eccles et al., 1983; Wigfield & Eccles, 2005). Given this, it was logical that the perceived advantages of enacting this study's learning innovation would make students choose to engage with the innovation as well as persist In other words, when students had a strong positive expectation about the approach they chose to engage with and persist for the betterment of their learning (Towndrow et al., 2010).

As mentioned earlier, students in this study evaluated and raised their concerns around the three areas in their pre-experience evaluation of the approach. First, they questioned *the relevance of the approach* given their learning context. They raised such issues as: whether or not the mode of organization of this learning approach would fit with their context; whether this learning approach had the ability to capture science content sufficiently as it used to be with traditional approach; and whether the contextualized science learning had comparative advantages over the traditional approach to science learning. The students seemed to believe some topics needed to be taught deeply and thoroughly, something they believed contextualized science learning could not offer. Secondly, prior to implementation of the study, students raised concerns around *the nature of syllabus in relation to time*. In this case, they believed the syllabus was too long and 'bulky', and hence, would require longer than usual to finish if taught through contextualized science learning approach. They shared that even with the traditional approach, involving students sitting, listening, and copying notes from their teachers, some teachers would not finish their syllabus, or they would but with difficulties.

Prior to implementation of the study, students thought they might spend too much time walking to find something relevant and tangible to learn, which would mean taking time from the classroom. In their pre-experience evaluation of the approach, students demonstrated what was seen as, *fear of learning non-examinable science content*. Because of the examination oriented curriculum, students believed their effort to learn was worthy only when it bore fruits in their exams, particularly in their final exams. Any effort to learn was to a large extent examination driven. Questions such as "will it be examined?", "can we be tested in this?", "is there possibility that we can be asked?", and the like, surfaced continually during pre-experience focus group discussion interviews and even in the informal interviews. The most important question was to ask, what did these students' pre-experience responses tell us? And how important were the responses, as far as the implementation of the learning innovation the study was introducing was concerned?

First, strongly as they were entrenched into traditional approach to science learning, students wanted to be assured they would transition smoothly from the traditional approach to a contextualized science learning approach. They wanted what Towndrow et al. (2010) termed as strong expectation and assurance they will achieve the desired outcomes or be successful in learning. These pre-experience results were mirrored in the results of other studies in classroom innovation. A study by Recabarren, Alvarez, and Diaz (2015) on how to help students embrace active learning by using more active learning, identified similar barriers to the implementation of an active learning strategy their study was introducing. These included students' resistance due to their strongly held traditional ways of learning, students' negative expectations of the content coverage, school norms and environment that discouraged innovations in learning, as well as the rigidity of time structure which prevented students from developing interest in active learning strategies. In their study on implementing strategies to mitigate students' resistance to active learning, Tharayil et al. (2018) identified effectiveness of the strategies in aligning with the needs of the learners, as well as possible negative responses from students, as barriers towards the successful implementation of the new classroom innovation. According to expectancy value theory of achievement motivation, students will arrive at a comfort level and choose to engage with the learning innovation only when they feel the new learning innovation is likely to produce more positive results compared to the old one.

While the students' pre-experience responses were not resistant towards the approach introduced in the study, they noted there were fundamental issues to be addressed . Tharayil et al. (2018) suggest that in such situations strategies must be employed carefully, in order to enhance smooth transition to the new classroom innovation. Two main strategies may be employed to mitigate such a problem, the explanation strategies and the facilitation strategies (c.f. Nguyen, et al., 2017). The explanation strategies involve explaining thoroughly at the outright, the purpose of the activity(ies), the subject expectations, the activity expectations, and the outcome expectations, whereas the facilitation strategies involve approaching the non-participants, helping the groups, inviting questions, and designing activities for participation.

Explanation strategies describe the purpose and the benefits of the innovation, and that it works better at the beginning of implementation, and facilitation strategies promote engagement and keep the innovation activities running smoothly once it has already began (see also DeMonbrun et al, 2017; Nguyen, et al., 2017). Such strategies as those suggested by Tharayil et al. (2018) and Nguyen, et al. (2017) were important in making the present study a success. Thus, based on the pre-experience results, before implementation of the study, the purpose of contextualized science learning was explained thoroughly to participating students and teachers. These included the purpose of each and every activity involved, the organization and implementation procedures of the activities, the expected content to be covered in each activity as per curriculum, as well as and the students' learning procedures..

At the forefront of the pre-experience responses was students wanting their time used efficiently and effectively in order to improve learning and eventually, better achievement in science (Serdyukov, 2017). The pre-experience sentiments students demonstrated indicated they wanted to be assured learning through this approach would help them meet their expectations, that is, that it would be translated into their exams by helping them earn good grades/ or performance. They did not want to 'waste their time' with topics or content unlikely to appear in their exams. As Neema concluded when she provided her views about the approach prior to implementation of the study "…it would be good to know what to concentrate with, when we are there [when visiting the *Wajasiriamali* production sites], lest not waste much of our time to learn something that will not come in our exams".

The students aired their views about the approach right from the beginning of the study which alerted the researcher and participating teachers to think about ways to implement the approach that would cater to the needs of learners as well as the needs of the learning approach (Kwek, 2011; Nisbert & Collins, 1978). Addressing change and innovation in learning, Nisbert and Collins (1978) and Kwek (2011) proposed the need to involve participants in making decisions on implementing the innovation, especially procedural issues. Although Nisbert and Collins did not specify student involvement in decision making regarding classroom innovation, Kwek (2011) in his study on classroom innovation and design thinking for 21st century, proposed student involvement at some stage during planning and setting of the implementation strategies. According to Kwek, the tasks would foster students' motivation and perception making the learning innovation manageable and accomplishable, because they were part of the procedure and task organization. In this students were involved in proposing various procedures to organize and implement contextualized science learning activities, including providing their views on how to cope with syllabus size versus time constraints. For example, they proposed that similar ideas, concepts or topics should be explored and learned together during the real-world learning cycle of the contextual learning (during the study visits). They believed this would save time while at the same time resulting into a more meaningful learning experience.

The students’ proposal was taken up by the researcher and participating teachers, and together with students, they agreed that during *Wajasiriamali* study visit learning cycle, students would explore ideas and/or concepts from different science and math subjects to learn how they relate with one another, connect, and are applied together in a real world setting. This would then reduction syllabus size, not by removing the topics but through learning various concepts or topics, all at once, in one activity. During implementation students were given the choice to select topics they believed would be interesting to experience through this approach to science learning. As will be seen in the discussion of the post-experience results, this student choice initiative proved effective. Students were able to identify topics or concepts in syllabus, and organize their own contextualized science learning activities in their own time outside the class hours, which further saved the time for regular class activities, while bringing in more learning.

Given that the main aim of the pre-experience data collection was to examine students’ initial views of the approach, their views were taken into consideration and used to modify and improve study implementation. Just as Keeney-Kennicutt et al. (2008) proposed, student views were important in creating the balance between the student needs and the needs of the learning innovation. Hancock (1995) states the role of the teachers is to help students understand the innovation, what they are being asked to learn, why, how relevant it is, and more importantly, the value of the desired outcomes or goals, and that they can be successful at achieving these goals. Yet, Yadav et al. (2011) suggested that in implementing active learning strategies, instructors/teachers should acknowledge the challenge of the new approach and provide guidance, ongoing feedback, and support students throughout the process. Similarly, Bentley et al. (2011) proposed teachers must solicit and act on student feedback and suggestions right from the beginning of the implementation to instill a continued positive motivation (c.f. Donohue & Richards, 2009).

The researcher, together with the participating teachers, made use of the pre-experience questionnaire to introduce the contextualized science learning to students as well as assess their initial understanding of this learning innovation. Then, insights from the pre-experience focus group discussion interview with students guided the overall plenary discussion session. Together, participating students and teachers clarified issues which arose during the interview, as well as acted upon suggestions that came up during discussions. The pre-experience students' responses were important in forging the best way to implement contextualized science learning in this study.

Although expectancy value theory recognizes that students will choose and persist in learning activity because they have high expectations, and they see the value in helping them achieve their goals, the value of this learning approach in regard to science learning, was not explicitly discussed with students prior to study implementation because this study was exploring the value students saw in learning science through this approach. However, their views of the approach at the beginning of the study were fundamental, and to a large extent, determined the success of this science learning study as will be seen in the discussion of the post-experience results in the next subsection.

5.1.2 Post-experience perceptions

Contrary to what students perceived about the approach prior to implementation of the study, a remarkable change in their perceptions was observed having gone through the eight months of contextualized science curricular experiences. Results of the post-experience questionnaire showed that almost all students confirmed the connection between the school science and *Wajasiriamali* production activities and this was no doubt an opportunity for meaningful learning of the school science. Further analysis of the responses through exploratory factor analysis followed by confirmatory factor analysis, showed students still evaluated the approach around three perceptual dimensions where the first and second pre-experience dimensions maintained, while the third dimension collapsed into a new one. Thus their post-experience evaluation of the approach revolved around: (1) *the nature of syllabus in relation to time*; (2) *relevance of the pedagogical model*; and the third new dimension, (2) *ability to understand and explain various science ideas or concepts*. These were considered the themes or key areas under which students evaluated the effect of contextualized science curricular experiences, and particularly, how they believed the experiences were influencing/ or influenced their science learning.

5.1.2.1 The nature of syllabus in relation to time

In this theme, students evaluated contextualized science learning by relating three aspects namely, syllabus size, time available to cover the syllabus, and nature of contextual learning versus the value of knowledge and learning gained through this approach. As reported in the analysis, having gone through contextualized science curricular experiences, students changed their position, and were of the view that the quest to finish syllabus and pass exams cannot supersede the advantages gained by learning science through this approach. Even though "completing the syllabus" and "passing exams" were important, students believed the science learned through this approach including application in their everyday lives was the most important. Having participated in contextualized science learning, students believed that learning for understanding and knowing how to apply the materials/knowledge learned in class in a real-world situation mattered the most. According to contextual learning theory, this type of learning, where students have the opportunity to connect and apply what they learn in school to real world contexts has the potential to create an environment where students become empowered in their learning experiences, broaden their ability to make connections, and enjoy discovery, which is important in science learning (Hull, 1995; Denisson, 2002). Moreover, Hull (1995) posits in such an environment “students can easily discover relationships between abstract ideas and real world applications…internalize concepts as they discover, and reinforce, and connect those relationships” (p. 32). The contextualized science learning in this study linked school science with the real world local context of the learners and enabled learners to see the meaning, and realize the immediate application of science in their everyday lives. Consequently, this appeared to have an impact on their increased motivation and interest to learn science. Also more importantly, the value for learning science, perhaps to the extent that syllabus length/ or coverage, including getting good grades in their exams, though important, would not supersede the advantages of this approach.

During post-experience focus group discussion interviews, it was clear how students acknowledged the approach. They declared that learning with *Wajasiriamali* gave them: ‘a chance to practice it’; ‘see and try out procedures’; ‘test in order to see if it is something that they can do’; and ‘do and produce something tangible, something useful’. Also the approach allowed them ‘to constantly think about the application of what they learned in school’ unlike the traditional approach. The students acknowledged that these features of contextualized science learning were ‘unlike’ the traditional approach, had much to add to their motivation and interest to learn science, and in particular, influenced how positively they responded to this approach during implementation of the study.

In fact, previous research reported how student motivation to learn and engage with science learning activities was influenced by context-based related learning experiences, similar to in this present study. A study by Bennett and Holman (2002) reported student interest and motivation to learn science increased through context-based related learning approaches. Likewise, Lubben, Campbell, and Dlamini (1996) reported increased learner participation and engagement /involvement in learning when context-based learning experiences were infused into school science learning. Studies by Nashon and Anderson (2013) and Zimmerman (2012) also reported students' appreciation of how meaningful learning contexts changed the way they understood science learning. Yet some other studies reported contrary results such as those documented in the present study prior to implementation of this study. A study by Taylor and Mulhall (2001), for instance, reported that students, parents, and society as a whole seemed to be skeptical regarding context-based learning approaches as they tended to 'water down' the mandated curriculum and deter students' plans to pass exams and acquire high quality employment opportunities. Changes in students' post-experience perceptions about contextualized science learning in this study could thus, be linked to the realization of the advantages associated with this approach as demonstrated in their views. More specifically, connecting school science with the local entrepreneurship community (the *Wajasiriamali*), might have made students feel they were not wasting their time with the approach. Rather *Wajasiriamali* became a dual opportunity for them to learn for academic purposes as well as being an alternative way to transition to the world of work, which is actually what the Tanzania National Education and Training Policy (ETP) advocates. According to ETP, education must help learners to smoothly transition to the world of work (URT, 1995, 2015). The current wave of engagement with local entrepreneurship activities in Tanzania due to scarcity of employment (UNESCO, 2014), might lead students to redefine their future academic and career priorities and opportunities and view engagement with such activities as those done by *Wajasiriamali* artisans as a good option.

Thus for the students, learning science with *Wajasiriamali* would not be a waste of time, rather, it became a meaningful and useful way of learning, valued above the need for syllabus coverage and examination grades. This theme illustrates, with or without our knowledge, students evaluate, at some point, the teaching-learning approaches we bring to the classrooms. As outlined in contextual learning theory and the expectancy value theory of achievement motivation (Hull, 1995; Towndrow et al., 2008; Wigfield & Cambria, 2010; Wigfield & Eccles, 2005), our teaching approach and the content that we teach depends on the value our students attach to what we do. Based on what students in the present study suggested, the issues of syllabus size and time for coverage, and overemphasis on exams can be outweighed by the value of learning gained through the approaches we bring to our students.

5.1.2.2 Relevance of the pedagogical model

Unlike their worries during the beginning of the study, where students demonstrated uncertainty as to the relevance of the approach in meeting their learning expectations, given the context, and the traditional approaches that they were deeply entrenched in, students seemed to positively endorse contextualized science learning, and found it relevant, having gone through the study. During post-experience focus group discussion interviews, students appeared to pay less attention to the issue of context relevance, and instead, focused more on how the approach was helping them to learn better, compared to the traditional approach to science learning. To them, the approach was being relevant because it helped them to learn meaningfully (which they defined as learning for understanding and retaining the materials), unlike the traditional approach which encouraged rote memorization of facts and ability to reproduce them during exams. Such sentiments as "…we never had time to do things practically", "…we never had field trips to learn academic things like this", "…you just sit there and wait to hear from the teacher…science is not like this", demonstrated the extent to which they were in a struggle with the traditional approach to science learning, and that, through contextualized science curricular experiences, they seemed to have found a solution. Connecting school science with the real world experiences such as those done by *Wajasiriamali,* helped them to learn comparatively better than through the traditional approach, and based on their views, made contextualized science learning more relevant.

During post-experience focus group discussion interviews, students acknowledged the fact that because through the approach, they were able to 'see it', 'try it out', and 'practice it'. The approach helped them improve their memory and made it easy to recall. They could comfortably explain the procedures, and learning materials and the procedures stuck with them. For the students, learning this way made it clear and real, and they were able to write things in their own words. Based on their views, seeing it, experiencing it, and practicing it, in the real world context, including getting the opportunity to compare to what they learned in class had a great deal of impact on their memory and understanding. This is consistent with what the contextual learning perspective endorses; when learners engage in learning, they do so with their mind and thought process engaged in the content and context of the problem., the conceptual structure of the activity, and the social milieu in which the activity is embedded (Brunner, 1987;

Hull, 1995). In doing so, they tend to find out how what they learn connects with what is happening in their everyday life environments; that is, seeking meaning in context by searching for relationships that makes sense and appear to be useful (Hull, 1995). Once they find the real world relevance and use of what they learn, research shows that they become more interested and motivated, and eventually, learn the subject matter more deeply, and recall it better (Lynch, 2002; Predmore, 2004; Verma & Habash, 2005). Students in this study acknowledged the role contextualized science learning played in making school science relevant and meaningful, and particularly, the authentic activities involved, which brought reality to the science learning.

Students finding contextualized science learning relevant could also be explained by the sociocultural theories/ perspectives of knowing and learning. Based on these perspectives, knowledge is considered to reside and go across the social and physical context in which it is used (Cole, 1991; Hickey, 2003). When knowledge is viewed in this way, learning becomes meaningful and successful, and learners internalize the knowledge via participation in the authentic activities taking place within the knowledge community (Hickey & Zucker, 2005; Vigotsky, 1978). Accordingly, participation in a community of practice provides cognitive tools such as new ideas, concepts, and explanations that help learners to make sense out of their experiences (Lave & Wenger, 1991). In a study conducted by Chen and Cowie (2013) where students learned about New Zealand birds in a socially relevant context, students achieved increased interest, motivation, and better understanding of the materials to the extent that it became easy for them to transfer the knowledge from teaching context to the new situations. Similarly, a study conducted by Bybee and MacCrae (2011) found that students' attitudes, interest, and motivation to learn science increased when science teaching was situated within their sociocultural milieu and related to aspects of the learners' lives. Eventually then, it seems that there is a relationship between learning through experiencing - authentic, sociocultural and contextual relevant nature of the learning activities, and the students' engagement, interest and motivation to learn (Hickey, 2003; Hickey & Zucker, 2005). The sociocultural and authentic nature of the *Wajasiriamali* learning activities students engaged in during the study period appeared to be the reason students positively endorsed contextualized science learning. According to them, it made science learning more accessible, meaningful, and relevant compared to the traditional approach to science learning.

5.1.2.3 Ability to understand and explain various science ideas or concepts

This perceptual dimension represents students' post-experience views or perceptions towards contextualized science learning, where, students evaluated the approach based on how it supported them in conceptual understanding. Consequently, based on their post-experience focus group discussion interview responses, students found the approach helped them deepen their understanding of various science ideas or concepts, including application in various real world settings. The real life learning activities helped students see the conceptual connections and relationships, and this furthered their understanding of the concepts, as well as knowing how to use them in everyday life. In the students' view, connecting what their teachers said in class with 'what they saw there, increased their ability to comprehend the concepts. Through this approach students had the chance to view and challenge concepts from different perspectives, something not offered by the traditional approach to science learning. In general, the relevance of the activities incorporated in contextualized science learning to their everyday lives, plus the organization of this learning approach, made it easy for students to connect their prior knowledge and experiences to new learning, and this was important in consolidating their knowledge and application of various concepts in science.

Based on the situated cognition perspectives, which are complementary to contextual learning perspectives, people learn particular knowledge and skills better when that learning takes place within the context in which the knowledge and skills are applied (Greeno, 1993; Lave 1991). Accordingly, learning in context involves adapting knowledge and thinking skills to solve unique problems, and is based upon the idea that "knowledge is contextually situated, and fundamentally influenced by the activity, context, and culture in which it is used" (McLellan, 1996, p.9). The sentiments that students provided in their post-experience stories showed that there is an opportunity to expand their conceptual understanding in adopting contextualized science learning. Based on the students' views, the authentic activities involved in this learning approach acted as another avenue through which to expand their comprehension ability of the concepts learned at school.

Brown, Collin, and Duguid (1989) posit that the practice in which students engage as they acquire knowledge or concepts shapes what and how students would learn. Consequently, learning is made possible when the knowledge and learning are grounded in multiple contexts, which allow students to explore the applicability of the concepts in solving novel problems. At the same time, Brown et al. (1989) observe that learning and transfer, is more difficult when a concept is taught in a limited set of activities. When students are taught concepts in only one context, they are not exposed to the varied practices associated with that concept. As a result, according to Brown et al. (1989), they often miss the concept's applicability to solve novel problems encountered in real life, in other classes, or in other disciplines. The consequence is less of the concept is learned, and in the end, the concept is easily forgotten because it was not well stored in the cognitive schemas of the students. Neema, Hamisa, and Jack, for instance were able to recall various activities that they engaged with during the study visits, including ability to comprehend the associated concepts that they learned in the activities. This was in itself sufficient to demonstrate the power in learning that is grounded within the context in which the knowledge is used. Furthermore, their ability to recall particular cases where specific concepts were applied in solving real problems, including ability to give reasons why, or explain how the concepts were being applied, was in itself a learning evidence. Anderson, Reder, and Simon (1996) pointed out it is only by encountering the same concept at work in multiple contexts that student can develop a deeper understanding of the concept and how it can be used, as well as the ability to transfer what has been learned to other contexts

5.2 Research sub-question 2: How does student success in this way of science learning influenced/affected their teachers' teaching?

This study also aimed to investigate what effects would student success in learning science through contextualized science curricular experiences have on their teachers' teaching. Emergent from the analysis of the focus group discussion interviews with teachers were three themes that responded to this research question. First, the analysis revealed that although students' experiences with contextualized science learning, elicited teachers' motivation and interest to help them learn science through this approach, conflict existed between teachers' efforts to help students learn through contextualized science learning, and the nature and organization of syllabus. Second, results indicated the benefits students derived from learning science through this approach had implications on how teachers interpreted and enacted the curriculum. In other words, students' experiences with contextualized science curricular experiences challenged their teachers' traditional ways of organizing, developing, and implementing science lessons. They began to devise different ways to incorporate elements of contextualized science learning in their day-to-day science teaching. Lastly, the analysis revealed this approach to science learning, acted as a catalyst through which collaborative teaching and learning among teachers and students was enhanced; something which both groups, teachers and students, declared did not exist before. The three themes responding to this research sub-question are discussed further in the next subsections.

5.2.1 Conflict existed between teachers' effort to help students learn relevant and meaningful science and the nature and organization of syllabus/curriculum

As noted in the analysis, the benefits of contextualized science curricular experiences that students began to demonstrate during the progress of the study, catalyzed teachers' motivation and interest to help them learn science through this approach. Yet, analysis of the focus group discussion interview responses revealed teachers' effort to help students learn through this approach conflicted with the nature and organization of syllabus/curriculum that did not give them sufficient flexibility to incorporate contextualized science curricular experiences in their teaching. Sifting through their interview responses, reveals teachers were highly cautious in terms of time, and whether or not the content/knowledge students gained through this approach would help them during exams.

One explanation for these teachers' sentiments is that the highly centralized and prescriptive nature of the curriculum/syllabus in Tanzania, plus the heavily examination driven style (Hamilton et al., 2010; O-saki et al., 2002; Rugumamu, 2011; Knamiller et al., 1995), gave teachers little or no room to be flexible. That is, they could not modify and/or incorporate innovative classroom teaching-learning strategies such as those brought by the contextualized science learning this study implemented. Teachers in Tanzania, as in many other countries which adopt centralized educational system (Akoth, 2016; Banaji, Cranmer, & Perrotta, 2013; Nashon, 2013; O-saki et al., 2004) are frequently measured by the success of their students. The measure of their performance is highly dependent upon the number of students passing in their subject areas (Osaki et al., 2004). As such, even with the benefits of learning science through this approach, which allowed students to choose the content and knowledge learned over the syllabus coverage and exam performance, teachers in this study still believed students' achievement in their final exams was of prime importance; thus, suppressing attempts to infuse contextualized science learning experiences in their teaching.

Issues of syllabus overload and examination driven curriculum and how they impair with classroom innovations have been acknowledged elsewhere in the literature (Akoth, 2016; Baloche & Brody, 2017; Banaji, Cranmer, & Perrotta, 2013; Bennie & Newstead, 1999; Hayes, 2013). A study conducted by Banaji, Cranmer, and Perrotta (2013) on barriers to innovation and creativity in schooling across Europe found that education policies emphasizing written summative exams inhibited teacher innovations and reduced the possibility of students' creativity. According to the authors, the importance of covering syllabus and achieving examination qualifications militated against risk-taking in learning situations and held back teachers' effort to infuse innovative practices in their classes. Moreover, the education policies emphasizing written summative examinations inhibited teachers' innovation and reduced the possibilities of student creativity. Similar problems relating to curriculum structure were reported by Baloche and Brody (2017) whose study that explored challenges of implementing cooperative learning innovation in the UK context observed that cooperative learning was not widely used because of teachers beliefs coupled with the perceived pressures of time to cover the syllabus, and the structure and organization of the curriculum. And this is also congruent with what Akoth (2016) and Hayes (2013) observed, where, teachers in their studies lamented the fact that long integrated and overloaded syllabus coupled with pressures to cover for examination purposes was a major challenge towards the implementation of the curriculum innovations that their schools were into.

Teachers in the present study demonstrated eagerness and enthusiasm to participate and engage students in learning science with the approach the study was espousing. Yet, they all expressed invariably how they felt vulnerable to the demands of curriculum as they attempted to enact the approach in their classes. Comments like "…you wouldn't think about this because this is what the syllabus stipulates" by Tina, "…in fact whenever you think about creating an activity, a lot of issues come around...time, the amount of context that you want to accomplish, students preparedness to engage etc" by John, and "…and they would wish to see the time that they spent in the study visits being translated into exams" by Christopher, echoed the feelings that accompanied them when implementing contextualized science learning in their classes.

However, while negative impact due to the rigidity and examination driven curricula have been reported frequently, studies indicated that with well organized, coupled with supportive implementation strategies as well as early emergence of positive learning outcomes (Koutselini, 2008; Nashon, 2013), teachers and students have gradually supported the adoption of classroom innovations and eventually rendered them a success. In her study on participatory teacher development, Koutseline (2008) found that the reflective, participatory collaborative involvement of teachers throughout the period of their study, proved to be transformative for all participating teachers. Furthermore, the gradual appreciation of participative inquiry, built into teachers the self-confidence, and devaluated the strong beliefs in authoritarian knowledge. According to them, situating the learning experiences within the experience of the teachers, plus the dialectic relationship between the teachers and the researchers facilitated to a great extent the construction of meaning. Together, these enabled teachers in her study to undergo gradual shift from imposed, predefined teaching and learning, to reflective collaboration and response to different needs of the learners.

As will be seen in the next theme, despite the conflict that existed between teachers' efforts to implement contextualized science learning and the nature and demands of the curriculum, teachers in the present study devised their own varied strategies to help their students benefit from the approach. This was made possible because both teachers and students were involved from the beginning to the end of the study in planning, development, and setting of the implementation strategies. This is similar to what Koutselini (2008) did in her study, and as Kwek (2011) and Nisbet and Collins (1978) suggested for the successful implementation of classroom innovations.

Nashon (2013) interpreted Kenyan science teachers' views about the effect of students' contextualized learning experiences on their teaching. In his study, teachers demonstrated an appreciation of the motivation that their students had in learning science from their local environment, and this had a considerable influence on the way in which teachers thought about science teaching, and the way they embraced the classroom innovation that the study was implementing. Consequently, even though teachers in Nashon's study had to strictly adhere to the official curriculum, they devised their own ways in which to infuse elements of the contextual science learning in their classes for the benefit of their students (Nashon, 2013).

Like Nashon’s (2013) study, it was tricky for the teachers in the present study to deviate from syllabus requirements – the dictate of sociocultural expectations regarding students’ success in their exams. Yet, students’ contextualized science learning experiences evoked in their teachers, awareness of their practices of teaching, in ways that pushed them to find out strategies to help students engage with relevant and meaningful science learning by incorporating aspects of the contextual science learning in their classes as will be seen in the next section.

5.2.2 The benefits that students derived from contextualized science curricular experiences had implications on how teachers interpreted and enacted the curriculum

Despite the teachers’ attempt to help students learn science through contextualized science learning approach conflicted with the needs and demands of the curriculum/ or syllabus, analysis of focus group discussion interviews showed teachers still incorporated this type of science learning in their lessons. Their views indicated that how students in their classes embraced and responded to the approach made them rethink and modify the way they interpreted, developed, and enacted their lessons to fit with their students’ needs. Consequently, they took a step further to devise contextualized or related science curricular experiences, even when these were not stipulated in the syllabus, to ensure they kept up with the motivation and interest their students demonstrated during the study.

Studies on teacher development and learning indicate that ideas and new practices of teaching are believed by teachers to be true only when they give rise to actions that work (Bolster, 1983; Guskey, 1986). What teachers believe about teaching and learning is what they see as having worked with their students (Guskey, 1986). Furthermore, changes in teachers' attitudes and practices of teaching are said to start primarily after some change in student learning (Bell & Gilbert, 2005; Koutselini, 2008). Although it may not be claimed with all certainty that teachers in the present study changed their instructional practices, in particular how they interpreted and enacted the curriculum based on this eight months project, their views demonstrated that their students' excitement, motivation, and engagement with the approach stimulated a need to rethink their practices in ways that attuned to their students rhythm of the approach. Deep in their views, they felt the need to revisit the ways of interpreting and enacting the curriculum, when their students embraced the approach and found it useful to them. A condition which, according to Guskey (1986), is said to be necessary in changing teacher beliefs and attitudes.

Looking at teachers as the main mediators between curricular reforms and school practices, Ariza and Gomes (1992) pointed out that teachers mediate between educational acts and the process of teaching and learning in a double process. While on the one hand, they use cognition to translate, analyze, and evaluate contributions that they receive from outside their own structures of knowledge; they on the other hand, act as practitioners in the classroom who make decisions based on the classroom practices as they interact with their students. Given this, what attracts teachers to engage in innovative classroom practices, and desire to change according to Arizona and Gomes (1992), is their belief that it will expand their knowledge and skills, contribute to their growth, and enhance their effectiveness with students (See also Goodson, Moore, & Hargreaves, 2006; Olsen & Sexton, 2008). The demonstrated differences in learning that students in the present study displayed during the study, the engagement and effort to learn, the urge and passion to ask and respond to questions, the need to link knowledge and real world practices unlike what it used to be with the traditional approach could be the reasons that teachers in the present study felt the need for change. In fact Lasky (2005) observes that one of the determinants for teachers' job satisfaction as professionals come largely from their interactions with students and the feelings they have some kind of positive influence on their students' academic success. The outcomes demonstrated by students were observed in addressing the first research question. Here they passionately supported the approach. The students saw how it was helping them learn meaningfully, support their conceptual understanding, and help them to put the school knowledge into practice. This made teachers to think it was the right time to reconsider their classroom practices so as to enable students learn better.

5.2.3 Theme 3: Contextualized science curricular experiences enhanced collaborative teaching and learning among the teachers and the students

In respect to this theme, teachers acknowledged that contextualized science curricular experiences transformed the learning environment into a mutual collaborative one. Whereas in the past, they worked individually in a teacher-centered teaching and learning environment, this approach seemed to develop and instill collaborative teaching and learning practices, which each teacher embraced.

Literature in collaborative learning reveals that most of the teacher collaborations or collaborative learning communities are formed by, or are a result of, the influence of the school leadership and/ or school culture and routine (Darling-Hammond & Richardson, 2009; Lieberman & Mace, 2008; Chance & Segura, 2009). Yet, Shulman (2004) posits that, "with teachers, authentic and enduring learning…requires collaborations. When teachers collaborate, they can work together in ways that scaffold and support each other's learning, and in ways that supplement each other's knowledge and experience" (p.515). Further, Shulman (2004, p. 515) points out that collaboration is "a marriage of insufficiency…there are difficult and intellectual and professional challenges that are nearly impossible to accomplish alone but are readily addressed in the company of others". It is possible that teachers in the present study felt challenged, in some ways, by the instructional approach that the present study was introducing, and to them, the company of others in their classes was necessary. In fact, interpreting events in *Wajasiriamali* required application of different knowledge domains, with each of the teachers being deficient in at least one domain of science knowledge, especially because in Tanzania, teachers undergo training in only two teaching subjects.

Subjected to a common teaching/learning activity outside the classroom, teachers in Buffun and Hinman's (2006) study acknowledged they had more opportunity to look beyond the isolation of classrooms and learn from each other. Eventually, they came up with a variety of ways to help their students learn better. Stoll et al. (2006) argue what teachers do outside the classroom can sometimes have significant impact on their students learning, because, they have more time to listen from each other, generate thoughts and insights, practice, and refine what they feel works for their students. Teachers in the present study might have found opportunity in working together. Initially, they collaborated only during lesson implementation stage, where they helped each other in assisting and managing students when visiting various *Wajasiriamali* working stations. However, they eventually extended the collaboration to their office (science teachers' office) where they began to discuss how to organize, develop, and implement contextualized science learning lessons. Their discussion included the best way to approach the entire syllabus. Study visits to the real world learning environment became a meeting point, and a point of ignition toward collaborative teaching and learning among the participating teachers. Contextualized science curricular experiences stimulated collaboration not only among the teachers, but also between the teachers and the students and among the students themselves. As Alice noted in section 4.3.3, having participated in several contextualized science curricular experiences, the social distance that existed among students, and between students and their teachers began to narrow down. According to Alice, students began to talk to each other freely, think together, and ask questions to themselves and to the teachers during class discussions, something which, according to her, was not there before. Besides, the reduced social distance between teachers and students made it easy for teachers to involve their students in planning and organizing contextualized science curricular experiences, as further noted by John in section 4.3.3.

Generally, the improved interaction among students, and between students and their teachers seemed to have transformed classrooms into collaborative learning environment where everyone in class became responsible in creating and recreating the learning and learning environment. These results are consistent with what other studies relating to out-of-school learning found (DeWitt & Hohenstein, 2010; Faria & Chagas, 2012; Griffin & Symington, 1997; Kelly & Groundwater-smith, 2009). According to Kelly and Groundwater-smith (2009), students enjoyed learning with their friends. Students in Kelly and Groundwater-smith (2009) study demonstrated that while they recognized that a visit to the museum was primarily designed to assist in their learning, they also wanted it to be a satisfying social occasion where they learned with and from their friends. In a study on student interaction in a school visit to a science centre, by Faria and Chagas (2012), students developed a behavior of ‘explaining’ to others, which demonstrated an emergent interaction aiming at learning from, and with others. Although some studies have cautioned about social barriers that sometimes hinder students' meaningful engagement with learning during science field trips, for example Anderson, Thomas, and Nashon (2008), a study that compared student discussions in museums and classrooms by Griffin and Symington (1997), found that school visit to museums assisted in building relationships between students through cooperative interactions and discourse.

The decrease in social distance and the emergent collaborative learning among students, and with their teachers during the period of the present study, could be linked to the 'unique' out-of-school learning environment shaped by the interactions and learning discourses that happened during the study visits which the students and their teachers had not experienced before. Although collaborative learning within the community of learners may not be surprising (Chan & Pan, 2006; Shulman & Sharin, 2004), these results reveal that contextualized science curricular experiences, modeled by and with the discourses around the real world learning experiences, such as those experienced by the students and teachers during *Wajasiriamali* study visits, may have promoted the emergence of collaborative learning that did not exist before.

5.3 Research sub-question 3: What factors in the current high school science teaching and learning in Tanzania prevent teachers from employing and utilizing contextually based mediations in the teaching and learning of the school science and how these could better be addressed?

The third and final research question entailed to explore factors preventing teachers from employing and utilizing contextually based mediations in the teaching and learning of the school science, and ways in which teachers and students think that these could be addressed. Analysis of focus group discussion interviews with both teachers and students, plus the informal conversations throughout the period of the study revealed three main factors. These are discussed in the following subsections.

5.3.1 The nature of curriculum and curriculum content

Teachers and students in the present study criticized the mandated science curriculum for being too comprehensive, overloaded, and prescriptive, and lacking spaces to bring teaching and learning creativity drawn from everyday life local contexts. Furthermore, teachers expressed concerns that for no apparent reason the syllabus to a large extent was disconnected from the real world context of learners. Yet the much of the content could be presented and taught through context-based mediations available within learners' localities. Given that syllabus and all curriculum issues in Tanzania are centralized and managed by the Ministry of Education via the Institute of Curriculum Development, teachers found it difficult to fully accept the contextualized science and related learning strategies. They did not want to 'mess up' the syllabus and/or the curriculum, and also the approach might be a misuse of their time due to their concern that the knowledge gained through context-based learning would not be on the examinations. The teachers also did not want to be in an unending rush to complete the extensive course syllabus.

These results were not surprising. Studies around context-based and related learning approaches reveal how the nature of the mandated curricula, the organization, implementation and evaluation, can be a challenge when attempting to implement these kinds of learning strategies (Bennett, et al., 2007; Coenders, 2010; de Jong, 2006; de Putter-Smits, et al., 2013; Fensham, 2009). In his work on chemistry curriculum in Sweden de Jong (2006) observed the structure of many modern curricula was still based on conventional relationships between school chemistry topics. Contexts do not often have a central position in curriculum. Hence, teachers are not often inclined to take context very seriously. Furthermore, in their systematic analysis, Bennett et al. (2007) noted teachers commented how hard it was ‘to complete without rushing’, and because of the nature of the curriculum, there was ‘too little time to do the course justice’. This is in despite teachers in their study commented that the approach was “…stimulating…up to date…highly motivating…very interesting …and that they enjoyed teaching it” (p. 1537). In a similar way, teachers in this study, though acknowledging the relevance of the approach, they believed the nature of curriculum organization and evaluation was one of the barriers to implementation of context-based related learning experiences.

De Putter-Smits et al. (2013), in keeping to the syllabus problem, pointed out that for a proper handling of context-based related learning, it is crucial teachers have ample time to reflect on the content, as well as decide on the specific approach they might invite in, before they engage in contextualizing the learning. Furthermore, the authors suggested it is crucial that teachers are involved in the planning and designing of the context-based related learning, including proposing the mode of organization and implementation. If teachers are involved in all these, it is likely to have significant effect in changing their cognition and attitude and eventually their teaching practices (c.f. Coenders, 2010 and Duit, et al., 2007). De Putter-smits et al. (2013) suggestions align with what Bennett et al. (2005) and Fensham (2009) observed. Due to the centralized and the prescriptive nature of syllabi and because context-based learning is a learning innovation, emergent after the decades of dominant conventional/traditional learning, this should be brought to teachers carefully; not as a mere top-down innovation to adopt, but rather to emerge through extensive involvement of teachers.

The present study involved the participating teachers in all important processes, including reflecting on the curriculum, redefining the objectives, planning and organizing contextualized science learning units/lessons, through to implementation processes. This could be the reason the teachers were able to keep up with the approach and worked out their efforts to come up with their own time friendly strategies to ensure that their students were going to benefit from the approach to the greatest extent possible.

5.3.2 Prior teacher preparation and schooling

The study results also revealed prior teacher preparation and schooling had significant influence on teachers' decisions about teaching. Their views of the approach highlighted their past experiences including teacher training and schooling as having a great deal of influence on how they viewed teaching and enacted classroom practices. Referencing their background, teachers highlighted: they had no real practical or hand-on experiences; they never attended field trips themselves for learning purposes throughout their training; and they studied and continue to work in an exam and grade driven environment rather than teaching with a focus on learning and knowledge development. John articulates this when he speaks about to encountering or experiencing difficulties in infusing contextualized science curricular experiences in their lessons: "…better the old approach…because it [is] the easiest way of doing things".

Teachers' association their schooling background with current practices of teaching is not a new phenomenon. Literature shows teachers tend to teach the way they were taught (Chicoine, 2004; Hall, et al., 2006; Lortie, 1975; Oleson & Hora, 2014; Pringle, 2006). Lortie (1975) coined what he called "the apprenticeship of observation" (cited in Cox, 2014, p. 3) where teachers have much experience observing professional teachers by the time they go to college to become teachers themselves. Because of that, according to Cox (2014), their training turns becomes just an initial opener or an initiation towards the teaching profession, which then requires a continued gradual mentorship, before they attain full professional teacher status. Unfortunately, because they teach in an environment similar to what they went through during their time at school/college (Pringle, 2006; Fensham, 2009), it becomes easier for them to relapse and develop more traditional teacher-led teaching strategies than the student-centered ones they might have been trained in during the college.

On the other hand, Hall et al. (2006) conducted a study on technological use in classroom and teachers teaching the way they were taught emerged as one of the reasons why technology is not often used in classrooms. Pringle (2006) also studied misconceptions in science and revealed the prolonged misconceptions in scientific concepts were very much associated with teachers teaching the way they were taught; hence the cycle continues. When Marshall (1991) surveyed teachers, asking them why they teach the way they do, the most common responses centered around this is the way they were taught, or this is the way they learnt best, or it was the easiest way to cover the content. Particularly with contextual learning, Fensham (2009) observed it can be difficult for teachers to teach in a manner that takes seriously real world contexts involving science and technologys, because their backgrounds are more likely in academic science rather than in application of science. In addition, he noted, they will not often have experience exploring the appropriate contexts to include in their teachings. From the point of view of the teachers,, it is highly likely a deeply engrained traditional teaching and learning background, played a substantive role in determining whether or not or the extent to which they would deploy context-based learning mediations in their science classrooms.

In keeping with the problem of innovation uptake in relation to teacher backgrounds, Chicoine (2004) criticized the continued traditional teacher education programs and pointed out in order to keep teachers from teaching the way they were taught, courses must exemplify active learning, something that teachers in the present study also supported. Moreover, Oleson and Hora (2014) suggested classroom innovations would be more effective if they were collaborative and supportive of teachers' growth as professional educators while also respecting their existing knowledge and skills (c.f. Darling-Hammond and McLaughlin, 1995; and, Fishman et al., 2014).

5.3.3 Mode of assessment/evaluation

In respect to this factor, teachers reported that the mode of assessment and evaluation deterred their efforts to incorporate context-based and related learning strategies as it relied solely on paper and pencil technique. This resulted in greater emphasis on assessment of knowledge of concepts and principles and less on assessment of conceptual and skills application. In other words, teachers' views highlighted the fact examinations were too theoretical and focused more on testing memorization of facts and principles and less of the application of the theoretical knowledge in solving real world problems. Because of that, teachers believed it was difficult for them to think of incorporating real world learning experiences. This would most likely be seen as wastage of time because it would not be part of students' continuous or summative evaluation.

In their systematic analysis of the research evidence on the effect of context-based and STS approaches to science teaching, Bennett et al. (2007) found teachers who taught a conventional curriculum were heavily influenced by the nature of examinations that are set for the courses, especially when the results were important for students' entry into higher education.

Despite the fact that as per teachers and the official statistics of examination results, even weaker students in context-based learning performed better than their counterparts in conventional programs, this was not enough to eliminate their worries. Similarly, a contextual learning study conducted in Kenya (Nashon, 2013) found teachers appreciated how students were successful in learning science through this approach, and the way this success positively influenced their teaching practice. Yet, even as they appreciated the approach, the teachers still felt constrained by the syllabus requirements, "a dictate of the sociocultural expectations regarding students' success in exams" (Nashon, 2013).

While results from Bennett's et al. analysis and Nashon's study seem to be consistent with what the present study observed, these results might be telling us, overall that examinations, the mode of evaluation of the curriculum, seems to be one of the major factors determining whether or not teachers incorporate context-based and related learning experiences in their day-to-day science teaching. The success of weaker students in exams due to the benefits of contextual learning which Bennett et al. (2007) found in their analytical study, was not sufficient to erase teachers' worries about exams versus the traditional learning approach. In Nashon's (2013) study, teachers appreciated the role students' success in contextualized science learning played in influencing their science teaching practices. Yet, they remained worried about exams. In the present study, teachers declared how students' enjoyment with contextualized science curricular experiences influenced the way they understood and interpreted science teaching and learning. Yet, they retained their skepticism regarding exams versus contextualized science learning. De Jong (2006) advises that, whenever possible, context related science learning should be given opportunity in the curriculum and curriculum evaluation if the intension is to encourage real world science learning. Alternatively, Bennett et al. (2006) proposed that examination bodies might offer to give specifications such that examinations following conventional or contextual learning are offered to give flexibility to students and teachers. Teachers in the present study suggested the incorporation of questions relating to what students observe and learn during contextualized science learning experiences, in order to encourage both teachers and students to adopt the approach in their classes for the betterment of student learning.

Chapter 6: Summary/Conclusions, implications and recommendations

The study presented in this thesis investigated the effect of contextualized science curricular experiences on students' learning and their teachers' teaching in a Tanzanian context. Drawing on their views/perceptions, the study examined how students and teachers experienced science learning that integrated both classroom and out-of-classroom real life learning activities in order to find out how this learning approach influenced science learning on the part of students, as well as classroom teaching practices on the part of teachers. Three research sub-questions guided the study: *1) How do Tanzanian high school students experience science learning in a science unit that integrates both classroom and out-of-classroom real life learning activities? 2) How does student success in this way of science learning influence/affect their teachers' teaching?* And, *3) What factors in the current high school science teaching and learning in Tanzania prevent teachers from employing and utilizing contextually based mediations in the teaching and learning of the school science and how these could better be addressed?*

This chapter presents summary of the findings, implications, and recommendations for curriculum and instruction, theory, further research, and conclusions.

6.1 Summary of research findings

As indicated in previous sections, this study aimed to bring science learning to the context of the learners by incorporating in the school science, experiences from learners' everyday life local environment. Research entailed investigating what effects this approach would have on students' science learning but also how student experiences with the approach would affect their own teachers' practices of high school science teaching. The study was conducted with two-Form 4 (Grade 12) classes of approximately 90 students each, in a selected (case study) secondary school, and involved two groups of *Wajasiriamali* manufacturing and processing artisans located not very far from the selected case study secondary school. The mixed method design was employed, with the quantitative and the qualitative methods administered before and after the implementation of the study to examine the effect of the approach from the point of view of the students' views/perceptions. While the quantitative questionnaire was used to examine students' views/perceptions of the approach before and after the implementation of the study and to also identify factors that underlay these views/perceptions, the qualitative focus group discussion interviews were used to further learn the views/ perceptions, by way of examining how they manifested across the perceptual dimensions that were obtained through the quantitative questionnaire. As for teachers, the focus group discussion interviews were conducted to examine how students' experiences with contextualized science curricular experiences affected/influenced their day-to-day practices of science teaching. Eventually, both students and teachers interviews were used to identify reasons why teachers would not prefer contextually based mediations in their everyday science teaching.

6.1.1 Research question 1

How do Tanzanian high school students experience science learning in a science unit that integrates both classroom and out-of-classroom real life learning activities?

Analysis of results indicated that even before implementation of the study (pre-experience), students were aware of the connections that existed between the school science and the activities done by *Wajasiriamali*, and that these activities had the potential to support school science learning. However, given it was their first time encountering this approach to science learning, they demonstrated skepticism regarding the approach. Based on the exploratory factor analysis, their skepticism revolved around three areas, namely: 1) *Relevance and use of the approach*, 2) *Nature of syllabus in relation to time*, and 3) *Fear of learning non-examinable science content*. Thus, prior to implementation of the study, students questioned such issues as: mode of organization of the approach; the ability to capture science content sufficiently; and in general, comparative advantages over the traditional approach to science learning. Furthermore, students stated the syllabus was too long and 'bulky'. Hence, teaching and learning through a contextualized approach would require a longer period of time to complete the syllabus. Because of the highly examination oriented curriculum, they also questioned the issue of whether or not the science content they were to learn through this approach would be examined. In general, prior to implementation of the study, students demonstrated their efforts to learn was worthy only when the outcomes would be present in their exams.

However, contrary to what they stated prior to implementation of the study, a tremendous change was observed having gone through the eight months contextualized science curricular experiences. The post-experience questionnaire results showed that almost all students confirmed the connection between the school science and *Wajasiriamali* production activities, and this was obviously an opportunity for meaningful learning of the school science. A further analysis of the post-experience questionnaire responses through exploratory followed by confirmatory factor analysis showed the first two pre-experience perceptual dimensions were maintained while the third dimension collapsed into a new one. Thus, *relevance and use of the pedagogical model,* and the *nature of syllabus in relation to time*, maintained, while *fear of learning non-examinable* *science content* collapsed into *ability to understand and explain various science ideas or concepts*.

Having gone through contextualized science curricular experiences, students changed their position. Unlike their pre-experience views, they were of the view that the quest to finish the syllabus and pass exams could not supersede the advantages gained by learning science through this approach. Although completing the syllabus and passing exams were important, they believed the science they learned through contextualized science curricular experiences including application to their everyday lives was far more important than the syllabus and exams. Furthermore, having gone through the experience, students declared the approach to be very relevant as it resonated well with their learning expectations. The experience helped them to learn science in a more meaningful way compared to the more traditional approach to science learning which promoted rote memorization and preparation for exams. Moreover, students commended contextualized science curricular experiences as helping them deepen their conceptual understanding including application in different real-world settings, which the traditional approach did not offer. The real life learning activities helped them to vividly see the conceptual connections and thereby furthered their understanding of the concepts as well as ability to apply their learning to everyday life settings.

6.1.2 Research question 2

How does student success in this way of science learning influence/affect their teachers' teaching?

Results of the analysis showed that student experiences with study's contextualized science learning elicited teachers' motivation and interest in relevant and meaningful science from their real world settings which did not exist prior to the study. Yet however, teachers' efforts to incorporate contextualized science curricular experiences in their classrooms conflicted with the needs and demands of the syllabus/curriculum which prompted teachers to focus on exams rather than the knowledge and skills gained by students. Furthermore, the study revealed the benefits students gained by learning science through contextualized science curricular experiences had implications on how teachers interpreted and enacted the curriculum. The students' experiences with contextualized science learning challenged teachers' strongly held traditional ways of science teaching to the extent they needed to devise various ways to incorporate elements of contextualized science learning in their classes for the betterment of their students' learning. Moreover, the study revealed student experiences with contextualized science curricular experiences stimulated collaborative teaching and learning among both the teachers and students. This according to the teachers and students, did not exist prior to their participation in this study.

The literature discusses teacher change from the point of view of professional development. This kind of change originates from either the traditional top-down model, arising from policy mandates where experts organize seminars and workshops or from school based professional development which originates from the school through teacher collaborative inquiry groups (Elmore, 2002; Fullan, 2014; Hargreaves, 1999; Loucks-Horsley, et al., 2003; Charles & Shane, 2006). Yet, there is little evidence documented regarding how teacher change and learning could originate from within their classroom through experiences with their students involving innovative classroom strategies such as contextualized science learning. This study has shown that positive student learning experiences can also present an influence on teacher change in their teaching practices.

6.1.3 Research question 3

What factors in the current high school science teaching and learning in Tanzania prevent teachers from employing and utilizing contextually based mediations in the teaching and learning of the school science?

The present study also sought to identify reasons why teachers would not prefer to use contextually based mediations in their everyday science teaching. Results highlighted three factors. First, the centralized, overloaded or ‘bulky’, yet rigid and prescriptive syllabus was stated by teachers as being the main reason for not using a contextually based approach. Despite the benefits of contextualized science curricular experiences each participating teacher acknowledged, they all lamented that ‘with this kind of syllabi’, was difficult to bring to their classrooms. Secondly, study results revealed prior teacher preparation and schooling backgrounds influenced how teachers interpreted and enacted the curriculum. Teachers pointed out they largely drew their teaching practices from what they saw and experienced during their teacher training and own schooling. Finally, the mode of assessment and evaluation seemed to have deterred teachers’ attempts to infuse context-based and related learning experiences in their day-to-day science teaching. The reason being examinations remained solely paper and pencil based, with emphasis was on the assessment of knowledge and recall of concepts and principles rather than assessment of real world application of the knowledge gained in contextually based learning experiences.

6.2 Conclusion

This study investigated how contextualized science curricular experiences influence students learning, which in turn, affect their teachers’ teaching. The study has contributed to the understanding of how students perceive the importance of context-based learning experiences to school science learning. In a situation where the emphasis is on competency- / skill-based relevant science learning, the study has shown that if well organized, both students and teachers are more than ready to engage in such a science and science learning approach. Furthermore, the study has demonstrated that culturally- relevant learner-centered methods can grow/emerge from within. Based on the results, when these methods grow/emerge from within, they seem to have the potential to be comparatively more sustainable than those imposed from the outside.

This study has also contributed to understanding how students respond to newly introduced classroom innovations. Although it was not a main objective, the study demonstrated how students react to newly introduced classroom innovations, and how they eventually respond to the innovations when made part of the organization and implementation process. Results of this study have implications for policy makers and curriculum developers in the move to create relevant and meaningful sustainable learner-centered science education and learning in addition to implications for theory and research.

6.3 Implications and recommendations for curriculum and instruction

This study largely responds to the concerns raised by several researchers and science educators on issues of relevance in science and science learning in Tanzania as well as similar contexts. Elsewhere in the literature, studies have indicated how idealized and prescriptive curricula and curricula materials have a negative effect on students' motivation, interest, and consequently, their success in science learning (Fensham, 2004; Hamilton et al., 2010; Knamiller, Osacki & Kuonga, 1995; Berns & Sandler, 2009). Concerns have been associated with the decontextualized nature of content, the transmissive nature of pedagogy and the unnecessary difficult attached to the school science teaching and learning (Hamilton et al., 2010; Lindahl, 2003; Lyons, 2006; Osborne & Collins, 2001). Yet, some other studies have indicated how context-based and related strategies benefit student because of the tendency to take into account and make use of learners' everyday local environment/context in the teaching and learning of the school science (Kasanda et al., 2005; Nashon, 2013; Bround & Reiss, 2010).

Results of the present study show students were excited and appreciative by the contextualized science curricular experiences and found an opportunity for meaningful science learning. Something they declared the traditional approach to science learning would not offer. While it cannot be claimed as an absolute, this approach proved successful based on the results of the present study, and the benefits the approach began to demonstrate during the period of the study indicates the approach has the potential to positively impact students' science learning, particularly, meaningful science learning. Students in this study were able to observe, practice procedures, try out their ideas, ask and respond to real world questions, interact with real world learning materials and activities, learn and see the applications, as well as apply the knowledge in real world situations. They made soaps and perfumes, practiced different food processing and packaging procedures, and learned and practiced the manufacturing of different domestic utensils while drawing upon and relating with the conceptions from the science syllabus which they contextualized through linking school science with the real world of *Wajasiriamali* manufacturing and processing activities. Learning science this way was commended by the participating students and teachers for being meaningful, 'worth it', and more importantly supportive of learning as the experience highly improved students' interaction, engagement with learning and memory, unlike the traditional approaches to science learning.

That being the case, my first recommendation for teaching goes to teachers and school administrations. Without the need to change science curriculum, teachers in the present study were inspired by contextualized science curricular experiences implemented by the study. They were able to devise their own strategies to incorporate contextual learning strategies in their lessons and offer their students the opportunity to learn science from real world contexts. As noted above, the real world of *Wajasiriamali* provided students an authentic environment to test their hypothesis, try out ideas, and eventually, see how the science knowledge they learned in school could be applied in their everyday environment in the solving real world problems. Dewey (1907), the progressive and experiential learning theorist, observed "there is an intimate and necessary relationship between the process of actual experience and education" (Dewey cited in Weinbaum, 1995, p. 4). Based on his experiential learning theory from which context-based *learning* draws, meaningful learning takes place when curriculum and instruction methods link with students' experiences and interests. Furthermore, Dewey argued education becomes effective only when content is presented to allow students to relate the information to their prior experiences, thus deepening their connection with the new knowledge. Building upon Dewey's ideas, contemporary scholars considered contextualized science learning as providing students with the opportunity to learn, connect, and employ academic understandings and abilities in a variety of classroom and out-of-school contexts to solve real world problems (Bern & Erickson, 2001; Lynch, 2002; Mason & Scrivan, 2004). Lynch (2002) for instance stated that through contextualized curriculum and instruction teachers are able to help students make connections with their roles and responsibilities as students, citizens, workers, and productive members of society.

While in recent years there has been a growing emphasis on learner-centered context-based learning in the education system in Tanzania, including amendment of its education and training policy in this direction, it is high time a step is taken further at least at the school level, to provide supportive environment for teachers that help them incorporate this type of science learning in their classrooms. Teachers in the present study did not have special training; neither did they receive a specialized training program for them to incorporate context-based learning in their lessons. A few hours of awareness building between the researcher and the participating teachers and students were sufficient to help them draw upon the syllabus, interpret, and open up the possibilities of incorporating contextualized science learning experiences in their classes. Furthermore, while regular class hours were initially utilized for study trips, only a few minutes were sufficient to plan for a contextualized science learning study trip. Students would use their own time to pay a learning visit to *Wajasiriamali* and then come together to share the learning experiences in a 15 to 20 minutes class presentation. All participating teachers indicated this worked well with their students. This is why they were motivated to find more ways to make the experience work. It may thus be a time for school administrations to play their role in making this possible by providing the enabling/supportive environment and be part of the arrangements to facilitate this type of science learning through schedules, timetables, follow ups, and encouragement; all in an effort to help students learn meaningful science and learn it better.

For policy makers and curriculum developers, findings of this study could inform the ongoing curriculum reform processes, including the need to provide the supplementary curriculum guides to help teachers implement the existing curricula through context-based mediations while at the same time, develop programs with the focus to improve teachers' ability to use context-based instructional practices for the benefit of students and the society at large.

6.4 Implications for theory

Since the purpose of the present study was to explore students' and teachers' views, perceptions, and practices of engaging in science learning that integrated both classroom and out-of-classroom real world socially and contextually relevant environment, the study was framed around the sociocultural theory, complemented by the contextual learning theory (Daniels, 2001; Hull, 1993; Hull, 1995; Karweit, 1993). Sociocultural theory holds that teaching and learning do not occur in isolation, rather teachers and students interact in a learning context where they construct ecology of social and cognitive relations in where influence between any of the parties involved is mutual, simultaneous, and continuous (Daniels, 2016). Accordingly, the views and perceptions of the parties involved do not develop instantaneously but rather, their involvement, and in this case in the activities connecting classroom learning with the real life world, have the potential to affect their views and perceptions regarding teaching and learning over a period of time (Nashon, 2003).

On the other hand, contextual learning theory contends that learning will occur only when students are provided with the environment to process new information such that it makes sense in their own frames of reference, that is, to their own inner world of memory and experience (Hull, 1995). The theory considers that when learners engage in learning, their minds will seek relevance of the learned materials in context, see whether or not the materials relate with their current environment, and whether the relationship makes sense and appear to be useful to them (Hull, 1995; Johnson, 2002).

I deployed the two theories in complementary fashion because by the nature of the study, learning involved active interaction, co-participation, cooperative/ joint construction of knowledge among the students and between the students and their teachers in an attempt to create the links between prior knowledge and experiences and ideas and concepts learned in the school science, within socially and contextually relevant environment (Anderson et al., 2000; Nashon & Anderson, 2008; Parvin & Stephenson, 2004; Braund & Reiss, 2004). The environment provided learners with supportive real world tools and objects for learning to help them participate and support each other in meaning making through collective collaborative learning activities. Teachers instructional activities on the other hand, were to direct attention, monitor the ongoing performance and engagement with learning, monitor conversation, and adjust the degree of assistance depending on the nature of activities (Hodson & Hodson, 1998; Palincsar & Brown, 1984). Given this environment, learning therefore took place through participation in discussions, dialogues, observations, demonstrations as well as real practices. This process necessitated tools of analysis capable of illuminating, the learning context, the patterns of communication, the learning relationships, roles and values attached to the learning approach, and the methods of knowledge construction if participants' authentic views and/or perceptions were to be sought (Braund & Reiss, 2004; Forman & McPhil, 1993; Martin, 2007).

Thus, the two theories worked together in understanding the dynamics of the students and teachers views/perceptions and more specifically, how their views or perceptions carried their motivation, emotion, attitude, and interest to learn science through contextualized science curricular experiences. Furthermore, the two theories together, were important in understanding how learners gradually recognized, evaluated, revised, and reflected upon their learning frameworks as they engaged in relating the school science with their everyday life experiences in different contextually and socially situated setting (Rogoff, 1995). Moreover, this combination of the two frameworks was important in informing how students' experiences in learning science through the real world local context impacted the philosophy of teaching and learning held by their teachers, as well as the value they placed on this approach to science learning (Robbins, 2005).

However, given the implementation of contextualized science learning was a new approach to this learning community, prior experiences of the learners indicated they held with them skepticisms regarding the approach. It was therefore deemed appropriate to deploy another theory, the expectancy value theory of achievement motivation (Wigfield & Eccles, 2000), mainly due to students' hesitations seemed to revolve around whether or not they would achieve the desired learning outcomes. According to the expectancy theory, individuals will choose to engage and persist in an activity only when they feel there is advantage in engaging with the activity. In other words, their engagement with the activity is the function of their beliefs about how well they will do the task or activity and the extent to which they value that particular task or activity (Eccles & Wigfield, 2002; Wigfield & Cambria, 1992, 2005; Wigfield, 1994). The expectancy value theory was therefore important in informing the experience students went through before they participated in the study; the experience which actually was important in shaping, modifying and improving the approach before its implementation. Thus, although the social cultural and contextual learning theories were thought to be the key to informing the study, the emergent results necessitated an invitation of another theory in order to inform the study and make the study as complete as possible.

6.5 Implications and recommendations for further research

Drawing on their views/perceptions, the present study aimed to investigate the effect of contextualized science curricular experiences on students' learning and their teachers' teaching in the Tanzanian context. Given that it was the first time that this type of science learning was introduced in Tanzania, and because of the research time limitation, the present study could only go as far as to examine the views/perceptions on how this approach would influence students' learning and achievement, as well as their teacher practices of teaching. As the analysis indicated, promising results began to emerge, where both participating teachers and students acknowledged the potential of this approach in supporting and improving school science learning. Given the study's limited time, it was difficult to collect sufficient solid evidence linking students' achievement due to their participation in contextualized science learning. Yet, data on this would be of vital importance, if this learning approach is to become sustainable in such an education system as in Tanzania where the outcomes of education are highly determined and measured by students' performance/achievement in their exams.

That said, my first recommendation is, there is a need to conduct a study, and more specifically, a longitudinal study, to collect both the quantitative and qualitative evidence of students' learning outcomes due to this approach to science learning. This data would thus, encourage teachers to confidently infuse this science learning approach in their everyday science teaching. As Guskey (1986) pointed out, teachers will only believe in the learning approach they see has worked with their students. In such an examination driven curriculum, teachers are gauged by their students' achievement in exams (Nashon, 2013, Osaki, 2004). Given that the Tanzania education system is currently adopting the skill-based education (competence-based curriculum), which is in consonant with contextualized science learning, evidence from a broad longitudinal study would add to the justification sought by policy makers and curriculum developers, for the official inclusion of this approach to science learning in the school science curriculum.

Many studies on teacher development and learning have focused on the contemporary models of teacher change, which mainly take the form of professional development (PD) programs through workshops and seminars (arising from policy mandate) or through job-embedded teacher collaborations (which grow from within the schools). These programs focus on teachers as change agents, where change in teachers is expected to be influenced by the teachers themselves. Little is known, explored, or explicitly acknowledged, on how students learning experiences might influence teacher change. Yet, based on the results of the present study and other recent studies, (for instance, Nashon, 2013), this study's context could probably be one of the formats to influence teacher change. It might therefore be of interest to conduct an in-depth empirical study that entails to systematically establish comprehensive evidence of how student learning experiences might impact teacher practices and how this could be made sustainable.

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APPENDICES

APPENDIX I

Curricular topics and *Wajasiriamali* sample lessons/activities

Biology

Curriculum topic I:
Nutrition: Properties of food substances; Food processing, preservation and storage; Respiration (e.g. anaerobic respiration)
Wajasiriamali experience: identifying food substances contained in soya milk, matembele, coconut milk, cassava etc. Processing and packaging of such foods as tomato sauce, chili sauce, mango pickle, soya milk, honey, sugar cane juice, tomato juice, mango juice; etc.

Chemistry

Curriculum topic I:
Organic chemistry: Alcohols and Carboxylic acid properties and functions; Detergent properties, manufacture and use.
Wajasiriamali experience: Powder soap making; Liquid soap making; Bar soap making; toilet cleanser; Perfume making, All from both natural and chemical raw materials.

Curriculum topic II:
Heat, Combustion and Rusting: Meaning of combustion; Demonstrate combustions; Application of combustion (e.g. in burners, engines, metal works etc.); Meaning of rusting; Causes and conditions for rusting; methods of preventing rusting (e.g. greasing, painting, coating etc.)
Wajasiriamali experience: Manufacturing of brightly shining metal boxes, chicken brooders, Local types of cookers - Jiko (metal jiko and clay jiko); Local furnaces, forging of iron tools (e.g. frying pans, cooking pots, toasting pans, toasting spoons etc.

Physics

Curriculum topic I: Work, energy and power; Law of conservation of energy
Wajasiriamali experience: Fireless metal cookers/jiko; Fireless clay cookers/jiko; *Wajasiriamali* barbecue ovens;

APPENDIX II

Guiding questions during interaction with *Wajasiriamali*

1. What products do you manufacture?
   (Mnatengeneza bidhaa gani?)

2. What are the main materials that you work with?
   (Mnatumia malighafi zipi kutengeneza bidhaa hizi/hizo?)

3. What is the source of the materials you use in your products?
   (Malighafi hizo mnazipata wapi?)

4. Are the materials recyclable or reusable? Alternative use of the materials?
   (Malighafi hizo zinaweza kutumika kwa kazi nyingine? Zina matumizi mbadala?)

5. Are there other materials that can be used for the same purpose?
   (Kuna malighafi zingine ambazo zaweza kutumika kutengeneza bidhaa kama hizi?)

6. Why have you not used these others?
   (Kwa nini hamkuzitumia?)

7. Show us the different types of products? Which ones are commonly bought and why?
   (Kati ya bidhaa mnazotengeneza, zipi hununuliwa zaidi na kwa nini?)

8. What other products besides these have you produced?
   - How well does each product sell?

   (Kuna products gani zingine mnatengeneza? Zinauzika?)

9. What properties do you consider when choosing these materials?
   - How durable are these products?

   (Mnaangalia nini/ubora gani ili muweze kuchagua malighafi?)

10. Can they be improved upon?
    (Mnadhani ubora wa malighafi mnazotumia unaweza kuongezwa? Kwa vipi?)

11. How suitable are the final products to the user?
    (Products zenu ni nzuri kiasi gani? Zinapendwa? Hazina madhara?)

12. What possible improvements or alternatives do you consider?
    (Mnadhani nini kinaweza kufanyika ili products zenu ziwe bora zaidi?)

APPENDIX III

Post visit in-class activity guiding questions

1. Out of the total number of stations you visited, identify three production activities that you found most interesting and where you learned the most. Rank them in order of merit and give reasons in each case.

2. Identify the product that requires the highest skill level to produce and give reasons for your suggestions.

3. What product evoked your science knowledge most and why?

4. How, in your view, can the production process and the final product identified in Qn 3 above be improved?

5. What personal strategies of learning science does this way of experiencing science evoke?

6. Make 10 minutes class presentation of your group responses to Qn 3,4,5 and 6. Decide on presentation strategy where all members participate.

APPENDIX IV

Students' questionnaire

Answer the questions by putting a tick (✓) in the respective box to indicate your degree of agreement or disagreement with the statements.

S/No.	Statement	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1.	School science has connection with *Wajasiriamali* production activities					
2.	I think there is a lot of interesting science that we can learn through visiting and/or interacting with *Wajasiriamali* production groups					
3.	My way of explaining various science ideas and concepts can change due to participation in *Wajasiriamali* learning activities					
4.	Learning science through visiting *Wajasiriamali* production groups can be time consuming					
5.	It is not helpful to learn science that will not be tested in exams					
6.	Learning science through *Wajasiriamali* learning activities can be difficult because there are no books that explain science taking place in *Wajasiriamali* production and/or processing activities					
7.	I think learning activities from *Wajasiriamali* study visits can help me to pass my exams					
8.	I can confirm that the science taking place in *Wajasiriamali* production activities has relevance with that which we learn in school					
9.	In order to pass exams, I need to concentrate alone rather than participate in group learning					
10.	Science is involved in making *Wajasiriamali* products					
11.	Learning science through *Wajasiriamali* study visits can help me to know that science is beyond classroom and laboratories					
12.	Learning science through study visits is interesting					
13.	The *Wajasiriamali* study visit learning activities can enforce group learning which is important in science learning					
14.	I fear, if we learn science through visiting the *Wajasiriamali* we will not be able to finish syllabus					
15.	The *Wajasiriamali* learning activities can help me to understand some difficult science concepts					
16.	The *Wajasiriamali learning* activities can help me to better explain some science ideas to my friends					
17.	Science syllabus is too long to incorporate learning activities from *Wajasiriamali*					
18.	Science activities including the activities from *Wajasiriamali* study visits are only useful if they can help me to pass exams					

APPENDIX V

Students' FGD interview guide

1. What can you explain regarding your experience of interacting with the *Wajasiriamali* groups/group activities? OR in other words,

    - What can you say regarding the contextualized science learning

    - Contextualized school science curriculum and instruction

2. What specific science ideas or concepts do you think were relevant to the science we learn in school during the *Wajasiriamali* study visits?

    - What did you connect with as far as PH, CH, & BL is concerned during our study visit?

    - OR What specific science ideas? – recall what you learned through out Form I II III & IV

3. Say something about the quality of *Wajasiriamali* products compared to other similar products. How do you think they could be modified or improved?

4. How have this way of learning changed your views and perception regarding science, and science teaching and learning?

5. How do you think this way of learning have influenced/will influence your approaches to science learning as well as performance in science subjects? OR in what ways would you say that the *Wajasiriamali* science learning experience has changed you way of learning science?

- Have you ever thought how you would learn certain science concepts outside the classroom?
- Has it changed your attitude towards science? How?
- Do you enjoy learning in groups? Explain more please?
- What other science strategies would you prefer other than those we used in this project?

6. What do you consider the challenges ahead regarding this approach to science teaching and learning?
    - How would you criticize the science curriculum and instruction, having gone through this model/style of learning?
    - Say something about language of instruction in this model of learning
    - Why do you think your teachers do not want/or prefer to use this model of learning?

APPENDIX VI

Teachers' FGD interview guide

1. What can you say regarding your experience of teaching high school science by incorporating real life learning activities such as those done by the *Wajasiriamal*i groups?

2. What specific science ideas or concepts do you think your students found most relevant to school science during the *Wajasiriamali* study visits?

3. How have students' success (or failure) due to this way of learning changed your views and perception regarding high school science teaching and learning (your pedagogical practices/ your culture of teaching high school science)?

4. What factors from the current high school science curriculum do you think prevents you from employing the contextually based mediations in the teaching and learning of the school science? How best can these be addressed?

5. What do you consider as the challenges ahead regarding this approach to high school science teaching and learning?

6. Comment anything concerning relevance of the current science curriculum to this approach to science teaching and learning.