



Strathmore
UNIVERSITY

Strathmore University
SU+ @ Strathmore
University Library

Electronic Theses and Dissertations

2018

A Case study investigating ways to improve the science learning environment to foster teaching and learning in the primary section of borough school

Juliana Gitonga
School of Humanities and Social Sciences (SHSS)
Strathmore University

Follow this and additional works at <https://su-plus.strathmore.edu/handle/11071/5963>

Recommended Citation

Gitonga, J. (2018). *A Case study investigating ways to improve the science learning environment to foster teaching and learning in the primary section of borough school* (Thesis). Strathmore University. Retrieved from <http://su-plus.strathmore.edu/handle/11071/5963>

This Thesis - Open Access is brought to you for free and open access by DSpace @Strathmore University. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of DSpace @Strathmore University. For more information, please contact librarian@strathmore.edu

A Case study investigating ways to improve the science learning environment to foster teaching and learning in the primary section of borough school.

Juliana Gitonga

Submitted in partial fulfillment of the requirements for the Degree of Masters of Science in
Education Management, Strathmore University

School of Humanities and Social Sciences
Strathmore University Nairobi, Kenya

June, 2018

This thesis is available for library use on the understanding, that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement

Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

© No part of this thesis may be reproduced without the permission of the author and Strathmore University

Juliana Gitonga

Signature_____

Approval

The thesis of Juliana Gitonga was reviewed and approved by the following:

Dr. Alfred Kitawi

School of Humanities and Social Sciences,
Strathmore University

Prof. Christine Gichure

Dean, School of Humanities and Social Sciences,
Strathmore University

Prof. Ruth Kiraka

Dean, School of Graduate Studies,
Strathmore University

Abstract

The purpose of this case study research was to investigate ways to improve the science learning environment to foster teaching and learning in the primary section of Borough School. The study addressed the science room as a tool for learning with a special emphasis on content, process and structure of the room. The first stage was to assess the situation of the learning environment and find the suggestions required to lead to an improvement. Both students and pupils of Borough school were involved in this assessment. The second stage involved looking for ways towards the desired improvement with the support of the teachers of science in the school. The improvement suggested for the science room was implemented and its effects assessed towards the end of the study. The outcomes of the research in terms (the room, relationships, instructional materials, knowledge and skills) with its appropriate sub-aspects were identified as critical in fostering teaching and learning of science. The improvement enhanced the attitudes, relationships, knowledge and skills of teachers and is hoped to enhance the performance of the pupils at the national exam. It also archived the materials and resources, in one place for ease of use and to encourage use, order and organization of the room by all members of science panel in the school. Since the study is a case study research, the outcomes of this research can be used to develop a quantitative study of a number of schools to check whether the aspects and sub-aspects identified as critical pillars in the teaching and learning of science can be generalized to a wider population. Case study research methodology was used involving teachers and students of Borough School as sources of evidence for the study. The study found that to improve the teaching and learning of science, the learning conditions for the students and teacher preparedness should be improved as well as focus attention on improving teacher quality and the social environment in the school.

Key terms: Science Learning Environment, Teaching and Learning, Relationships, Knowledge and Skills, Instruction Materials, Learning Goals.

Table of Contents

Declaration	ii
Abstract	iii
Table of Contents	iv
List of figures	vii
List of tables	viii
Acknowledgements	x
Dedication	xi
Chapter 1: Introduction to the study	2
1.1 Introduction.....	2
1.2 Background to the study	2
1.2.1 My personal background	3
1.3 Problem definition.....	4
1.3.1 Importance of science in education	4
1.3.2 Importance of Science in the Kenya.....	4
1.3.3 Challenges of Science in Kenya	5
1.3.4 Science in Girls' Schools.....	5
1.3.5 Overview of performance in Borough School	6
1.4 Rationale of the study.....	7
1.5 Research that exists in the area	7
1.6 Research questions	8
1.7 Significance of the study	8
1.8 Limitations of the study	9
1.9 Overview of the structure of the study	9
Chapter 2: Literature Review	10
2.1 Introduction.....	10
2.2 Challenges of science in education	10
2.3 Challenges of Science in Girls' Schools	12
2.4 Theoretical framework.....	13
2.4.1 Theories of Science learning environments	13

2.2 Conceptual framework	16
2.6 Summary of the chapter.....	18
Chapter 3: Research Methodology	19
3.1 Introduction.....	19
3.2 Ontology and epistemology	19
3.3 Research approach.....	19
3.4 Operationalization of science learning environment.....	20
3.5 Methodology	21
3.6 Participants.....	21
3.7 Data collection and presentation	22
3.7.1 Class observations	23
3.7.2 Face to face interviews.....	24
3.7.3 Open ended questionnaires.....	24
3.8 Data analysis	25
3.9 Validity and credibility	26
3.10 Ethical considerations.....	26
3.11 Summary of the chapter.....	27
Chapter 4: Presentation of Research Findings	28
4.1 Introduction.....	28
4.2 Instructional materials and media	29
4.3 Relationships.....	34
4.4 Learning goals.....	36
4.5 Knowledge and skills gap	37
4.6 Summary of the chapter.....	41
Chapter 5: Discussion, Conclusion and Recommendations	42
5.1 Introduction.....	42
5.2 Discussion	42
5.2.1 Student materials and instructional media for Science in the laboratory	42
5.2.2 Student relationships to cultivate in the Science learning environment	43
5.2.3 Science learning targets set for our students in each class.....	45
5.2.4 Knowledge and skills gaps in the primary section of Borough School	45
5.3 Conclusion	46
5.4 Recommendations	48

5.5 Challenges and limitations.....	48
5.6 Suggestions for further research	48
References.....	50
Appendices.....	52
A. The science lab before the intervention	52
B. The science lab after the intervention.....	53
C. Students’ reflections before intervention.....	54
D. Teachers’ reflections before intervention	55
E. Journal.....	56
F. Students’ questionnaire	60
G. Class observation guide	61
H. Teacher questionnaire.....	62
I. Teacher interview guide.....	63
J. Teacher Informed consent form.....	64
K. Student Informed consent form.....	65

List of figures

Figure 1 Framework showing the relationship between items in the study

List of tables

Table 1 Relationship between items of students' interest and student Instructional materials

Table 2 Relationship between items of teachers' interest and student Instructional materials

Table 3 Educational level

Table 4 Years of experience

Table 5 Highest level taught

KCPE- Kenya Certificate of Primary Education

MOEST- Ministry of Education, Science and Technology.

BVATT-Borough Value Added Training

KICD-Kenya Institute of Curriculum Development

CPD- Continuous Professional Development

MOE- Ministry of Education

STEM-Science Technology Engineering and Mathematics

Acknowledgements

I wish to take this opportunity to thank all my lecturers in Strathmore University for their professional support in making this research work a success. I could not have accomplished this without the many family members, colleagues and friends who have been there along the way. I thank you for pushing me to finish. This has been a difficult journey, which I often wanted to quit, but you kept me going.

Special gratitude to the following in Borough School: to the Academic council, for funding this research and supporting my financial and time needs throughout the study, to the teachers of the science panel and the students who participated in the research and for the time they put in to work with me throughout the study period, to Miss Khamati for directing my vision and thoughts and to Miss Roche for igniting the spark to make a difference in my practice and inspiring me to do this study.

Thank you Dr. Kitawi for keeping me on track, for directing me and making me believe I could do it. Your guidance, continual faith in me, support and encouragement have made this possible. I appreciate your invaluable insights and the time you spent reading and rereading each section of my thesis.

Special thanks to Margaret Kariuki, Josephine Mikui and Caroline Mbugua of the School of Humanities and social Sciences for encouraging me and my classmates to finish in time.

Dedication

I dedicate this work to my husband Peter and our sons, Maina, Gitonga and Mwangi for their understanding hearts especially when they missed my motherly warmth during the intense periods of my study.

To my parents too, for giving me a good education and encouraging me to rise above the comfort zone in education.

Chapter 1: Introduction to the study

1.1 Introduction

The aim of this case study research was to investigate ways to improve the science learning environment to foster teaching and learning in primary school. The aim of chapter 1 is to present an overview of the research by giving its background, defining the problem, rationale and its significance.

1.2 Background to the study

Borough School is a private, all girls' day school with a Catholic ethos. It is located in Nairobi County. Borough was started as a secretarial college in the early 1960s by a non-profit organization known as Borough Foundation. Borough was started with the aim of giving an all-round education to girls from an early age in order to better Kenyan women's lives through education and Christian values with emphasis not only on academics but also on spiritual life, fitness and character building. Borough has a secondary and primary school that are run separately and follows the local education system. Currently, the school has a capacity of 900 pupils, 600 of these are in primary school. In the primary school, several subjects are taught, six (Mathematics, English, Kiswahili, Science, Social Studies and Christian religious education) of which are examinable at the Kenya Certificate of Primary Education (KCPE). All the teachers in the school teaching a particular subject are referred to as a subject Panel. Each panel is trusted to devise different ways to enhance the subject performance in internal examination as well as the national examination, KCPE, at the end of the primary school syllabus.

The Science panel is one such panel in the school. During the period of this study, the panel had ten members who possessed a tool for preparation of experiments and teaching activities called a science room. The panel was allocated a room four years ago which served as science lab for the primary school. At that time its purpose was to store teaching materials. A few materials, such as sources of heat, sufurias, charcoal jikos and many handmade resources were available in the room (Appendix A). The room was in a dilapidated state because materials were stored anywhere in the room without any order, creating confusion and a lack of plan. The teachers and pupils who were expected to use the room felt it was in a seriously sorry state and required attention. Suggestions indicated that the room needed to be fitted with the required tools and necessary resources for teaching supplied (Appendix C, D). The structure, equipment and materials inside the lab begged for improvement to make the room conducive for teaching and learning. Teachers and students alike looked forward to a better environment that would enable them to achieve their goals. While

there was a shortage of a bigger room in the school, the teachers could make efficient use to the available facility if proper resources and materials are provided. The general feeling was that if the science environment was improved, there was a high likelihood of improving morale of both teachers and students and performance in the subject.

1.2.1 My personal background

I completed my Bachelor of Science degree in Agriculture Education and Extension in 1995 at Egerton University. I began my career teaching Biology and Agriculture in various secondary schools around the country from 1995 to 2006. In 2006 I moved on to teach Mathematics and Science for the first time in Borough Primary School. It was a challenging task but I really enjoy it now. Apart from teaching, I am charged with the responsibility of supervising teachers who are in the science Panel.

The experience I have acquired in the past twelve years has taught me the importance of quality teaching guided by syllabus requirements while aiming at achieving national goals for education. I believe in developing students' ability to learn and not only memorization of subject content. I have come to appreciate that the laboratory gives an excellent medium for teaching and learning. Knowledge of the subject matter and exposing pupils to classroom activities is not enough. It is important to plan out properly and have the big picture in mind so as to be able to bring together subject content with suggested activities at various levels. While planning to teach science the teacher should have an idea of the source of all her teaching requirements and tools for teaching. I am of the opinion that one cannot effectively teach science theoretically without engaging pupils in laboratory work since this will help them verify concepts learnt in class. Good teaching is characterized by teachers being enthusiastic about their subject and running well-ordered and stimulating science lessons. As a teacher, I value mutuality in class as well as professionalism that enhances quality teaching for the 21st century. Teaching for learning while taking care of syllabus coverage to achieve national goals of education ensures meaningful learning. I believe that faculty members should work together in an atmosphere of trust to improve themselves as well as for the betterment of students. I strongly believe in creativity and flexibility in meeting the essential requirements of the syllabus in order for students to make meaning of the things they learn in school.

These beliefs made me reflect on the Science teaching and learning environment in Borough. I perceived that having a Resource Centre that has all resources required for the primary school science course will enable the science teaching staff to teach while exposing the pupils to

laboratory work without skipping some important activity for lack of the necessary resources. These beliefs indirectly were the genesis of this research and helped to steer it to the right direction.

1.3 Problem definition

1.3.1 Importance of science in education

Science education is very important to the development of any nation. Teaching of science offers students the ability to access a wealth of knowledge and information which will contribute to an overall understanding of how and why things work the way they do (Quinell, 2016).

Science knowledge can be used to understand new concepts, instill survival skills, make well informed decisions and pursue new interests. Further, it provides proof of many facts found in books and experienced by students. This knowledge increases understanding and helps students to retain the information that they experience daily as well as create life applications. Students who excel in science develop a strong ability to think critically and logically and develop problem solving skills.

Since science enables students to develop understanding and form questions based on the knowledge they acquire and the insights they wish to gain in future, they are able to understand many other subjects' better. It is undoubtedly important to learn science from the early days of school. Science shapes the world around us and gives young people the opportunity to satisfy their curiosity about how the world works, knowledge that they can use to make important decisions in their lives and skills that will benefit them in future studies and employment.

1.3.2 Importance of Science in the Kenya

The vision for the Ministry of Education Science and Technology is “Quality Education for Development”. This will be achieved through the improvement of educational practices and programs. The education goals of the 2030 Vision are to provide globally competitive quality education and training and research for development. This is to be achieved through reducing illiteracy by increasing access to education, improving the transition rate from primary to secondary schools, and raising the quality and relevance of education. Specific issues were identified to achieve these goals including relevance of the education system to content and delivery, sufficient flexibility to adapt to the changing socioeconomic needs and requisite quality to match global competitiveness and to address the changes of the 21st century (GOK, 2007).

To encourage critical, independent and investigative thinking among young learners and for the development of a clear policy and legal framework on research, scientific skills are to be instilled

in schools. It is proposed that the content for basic education should be designed with a view of equipping learners with relevant knowledge that emphasizes on technology, innovation and entrepreneurship (Vision 2030), the development of their full capacities, living and working in dignity, enhancing the quality of their lives, making informed decisions and continuing with learning as a lifelong engagement. Major reforms of the curriculum are recommended to align it with the constitution and to ensure that the aspirations of Vision 2030 are met. Structure the curriculum within a skills and competences framework that identifies the knowledge, skills and competences all learners will acquire, and which will provide both vertical and horizontal coherence. Vision 2030 aims to capitalize on knowledge in science, technology and innovation in order to function more efficiently improve social welfare and promote democratic governance. According to science, technology, strategy and innovation policy, mathematics and science are the foundations upon which rests a country's leadership in innovation and its economic prominence (MOEST, 2015). They are required to build and sustain economic and scientific leadership.

1.3.3 Challenges of Science in Kenya

In Kenya, science education has been facing several challenges. These challenges include lack of laboratories in schools and if present, are inadequately equipped, limited space in the laboratories that cannot accommodate a standard class, lack of resources or insufficient laboratory resources and teachers avoid practical activities (Kaping'e P, August 2014). Other constraints are poor performance in national exams, inadequate staff, incompetent teachers and vast content to be covered.

1.3.4 Science in Girls' Schools

Several factors have been found to affect students' attitudes to science. These can be broadly defined as gender, quality of teaching, personality, structural variables and curriculum variables. According to Osborne (2003) gender is probably the most significant variable related towards pupils' attitude to science. Boys have a more positive attitude to school science than girls, although this effect is stronger in Physics than in Biology. Girls' attitudes to science are significantly less positive than boys and a lack of experiences in science leads to a lack of understanding of science and contributes to negative attitudes to science (Osborne, 2003). Girls' overall attitudes toward science are either less positive than boys' or decline more significantly with age. Brotman (2008) asserts that girls perceive science as difficult, uninteresting, or leading to an unattractive lifestyle,

parents have higher expectations of boys and perceive science to be more important for boys than girls and where girls enjoy and are involved in science class, their perceptions of their competence in the subject are lower than boys.

1.3.5 Overview of performance in Borough School

For the past several years, science KCPE averages in the school has been low. the KCPE performance recorded for 2011 and 2012 was 68%, 2013 was 69%, 2014 was 67% and 2015 was 70%. There was an improvement in KCPE performance in 2015 (70%) This can be attributed to the fact that teachers involved in preparing the candidates changed the approach to a more student centered approach. Classes which are not examined register a better average performance compared to the KCPE class.

In Borough, the science learning environment, specifically the science laboratory, did not support teaching and learning in a satisfactory manner. Given the aforementioned issues, and shown by evidence provided in the appendices section (A, C, D), the science learning environment was not appropriate to foster teaching and learning.

The room did not have the basic physical facilities needed in a laboratory like sinks and operable doors and windows, several materials were unavailable or non-functional and it was sometimes impossible to locate the available resources due to its dilapidated state. For these reasons, there was need to improve the environment in order to foster teaching and learning.

According to the national education policy (MOEST, 2015) it is expected that schools create an enabling environment for performance based learning. The 8-4-4 curriculum was intended to inculcate self-reliance, enable learners to be mature physically and get better prepared for secondary education and the world of work. This was expected to be achieved through all the subjects taught in the primary school, including science. The curriculum should emphasize more practical learning at all levels in the primary school. To enhance personal development, learners should have hands on experience with learning materials. They should be allowed to work with learning materials so that they gain their confidence and prepare for the future.

Together with the assistance of other teachers, my aim was to investigate how to improve the Science learning environment to foster teaching and learning. This included finding ways to address the deplorable state of the room so that items are stored well and teachers can prepare for

experiments comfortably through improving the instructional, infrastructural, and procedural and support materials.

As the researcher, I led the improvement of the state of the room and involved all the teachers of science in the primary school (Science Panel) to create a positive learning environment. In the course of developing the instructional materials, all the teachers were able to concretize the whole syllabus including the ones who never got a chance to teach the examination classes. The research was a vehicle for educating faculty in effective teaching methods and improving motivation and scholarship following their involvement in the research.

The new laboratory was aimed at facilitating proper storage of materials that are developed during the teaching process. From the new lab, it is now possible for teachers to access materials that have been used by others so as to save on time that was previously used to make new materials. By their involvement in the research, teachers shared knowledge and ways of teaching, giving them a chance to change their teaching approaches and strategies as part of improving instruction.

Although little could be done about the size of the room at the time of the study, the existing room was fitted with the required tools and necessary resources. Together with the teachers of science Panel we collected and bought all materials and stored them in an orderly manner in the available room.

1.4 Rationale of the study

The rationale of the study was to intensively investigate and locate the aspects needed to make the science learning environment conducive to teaching and learning. While investigating these aspects, the research informed strategies that improve teaching and learning in different levels in primary school through promotion of learning content and consolidation of teacher knowledge and skills.

1.5 Research that exists in the area

This is a case study research which has not been undertaken by me before and neither has another person researched or addressed this issue in this institution. The choice of this research was guided by an existing need in the school currently. This was a unique kind of research in providing content rich information on ways to improve science learning environment in a private school in Nairobi County as transformations took place as the research unfolded.

There are some studies which have tried to address the issue of Science Learning environment whose results are provided in chapter 2. Examples of such studies include: a) a study conducted to find how different school factors affect education outcomes. This study concluded that school managers should focus attention on improving not only the quality of teachers and teaching materials, but also the social environment at the school in order to stimulate more student effort (Hopland, 2016), b) another study conducted to find the factors that influence students' manipulative skills during transition from primary to secondary school concluded that primary school students need to be exposed to these skills in using scientific apparatus so that when they enter secondary school, attention can be given to improving and strengthening those skills. Incompetence in manipulative skills in science at primary level may impede science learning at secondary school (Fadzil, Dec 2014).

This research therefore provides a unique research premised on this unique institutional setting. It involves observation of the school with full analysis of a number of documents (accounts of subject teachers themselves) and comments given by participants in the research. The materials suggested by teachers and students and found necessary to bring the desired improvements were acquired and stored in the improved facility during the process of the research. These apparatus and materials were used to expose the students to manipulative skills for their level (Appendix C).

1.6 Research questions

The research questions are based on the literature provided in sections 2.3 and 2.4. The research questions are:

1. What student materials and instructional media do we need for Science in the laboratory?
2. What student relationships should we cultivate in the Science learning environment?
3. What Science learning targets should we set for our students in each class?
4. Which knowledge and skills gaps exist in the primary section of Borough School?

1.7 Significance of the study

Through this case study, the science room has been transformed into an effective tool to help achieve education goals more efficiently as it now provides information rich sources. Teachers will have saved time that was previously used to source for teaching materials. The school will save money in the long run since there would be no further need to buy these over and over again.

The Science learning environment is more aligned to syllabus and school's expectations and therefore will serve student learning needs better.

Other people interested in research in transforming schools may use this same approach to improve science learning environments in their schools. The research offers a contribution to existing theory on how to improve practice by offering explanations of possible processes needed to improve learning (Vaccarino, 2007).

1.8 Limitations of the study

In terms of context, the school is unique both in its founding ethos and the manner it has been constituted. This implies that the study results may not be replicated elsewhere. The outcomes of the research are also restricted to theories of Science learning environments.

The research has limitations of case study methodology. The research, which is qualitative in nature is expected to contribute to theory and practice yet the results cannot be generalized to another situation. The research refers to only one school. There is need for other researchers to conduct a similar study in other settings in order to develop better generalizations in terms of science learning reforms, this implies a further quantitative study. The case study technique is difficult to organize and outcomes are prone to problems of observer bias and as a research method, it is not easily open to cross checking given it is selective and subjective (Yin, 1994).

Interpretivist epistemology and subjective ontology were used in this research. This means the situation and the results were seen through the eyes of participants. Since case study research combines knowledge and inference this may become an object of criticism, questioning its respectability and legitimacy (Yin, 1994).

1.9 Overview of the structure of the study

This chapter has given the background to the problem, summarized the problem statement, the rationale of the study, significance of the study and limitations to the study. The following chapters will present the reviewed literature to the address the research questions, research methodology, the findings and discussion and conclusions of the study.

Chapter 2: Literature Review

2.1 Introduction

This chapter presents the background literature, the context of the study and values underpinning the research. It covers some theories that have been written on science, learning environments, importance of science laboratories, parameters used to present a science learning environment, science subject performance in KCPE with a focus on girls, the significance of the investigation and the conceptual framework for science learning environment. The chapter also gives an overview of the science learning environment in Borough.

2.2 Challenges of science in education

The field of science education includes science content, science process or scientific method and teaching pedagogy. There is a growing importance of science but an increasing problematic status of science and technology in many countries (Sjoberg, 2001). There is eagerness to use new technologies but reluctance to study the disciplines that underlie the products. This increased significance of science is not accompanied by a parallel growth in interest and understanding of basic scientific ideas and ways of thinking (Sjoberg, 2001).

In many countries there is a noticeable decrease in the numbers of students choosing sciences and in particular Physics and Mathematics and enrolment to tertiary education. There is more concern that the calibre of entrants to higher education in science and engineering is poor (Osborne, 2003).

There are marked limitations in the effectiveness of school science education as well as the need to re-orient the teaching-learning practices to focus on science as an art of acquiring scientific knowledge rather than as a rigid and cold method of knowing about our environment, selves and the processes operating at various levels to constitute life processes and affect our survival and ability to use and tame nature and its attributes (Hofstein, 1982).

One also observes a growing gender gap in the choice of Science and Technology subjects in schools as well as well as at the tertiary level (Sjoberg, 2001). The decline of interest in science remains a serious matter of concern for any society attempting to raise its standards of scientific literacy. Moreover, the pool on which employers can draw will be severely curtailed and not necessarily of the best quality (Osborne, 2003).

According to Atkinson (2007), as economies are becoming more science and technology based, fewer students, especially girls, are studying science, technology, engineering and math (STEM). A shortage exists in this area worldwide. To boost STEM talent, governments create an environment focused more intensely on science and technology that enables students to study science and math beyond the primary levels. Despite an increasing recognition of the importance and economic utility of scientific knowledge and its cultural significance, the falling numbers choosing to pursue the study of science has become a matter of considerable societal concern and debate (Osborne, 2003). This lessening interest in science and disaffection with science and technology amongst students will affect many areas in the wide world. All this leads to a widespread scientific ignorance in the general populace (Osborne, 2003).

A weaker quality of candidates may be a consequence of the fact that very few candidates compete to get places at institutions where the entrance qualifications previously were very high. Many tertiary Science and Technology institutions are unable to fill their study places with students. (Sjoberg, 2001). Industrial leaders are worried about the recruitment of qualified work force. Research gives evidence of a decline in the interest of young people in pursuing scientific careers, universities and research institutions are worried about the recruitment of new researchers and educational authorities are worried about the already visible lack of qualified Science and Technology teachers. In some countries, the grave situation for the recruitment of new students as well as for the substitution of those who retire has caused great national concern. This concern is often based on comprehensive reviews of the current situation in the education sector and the labour market (Sjoberg, 2001).

The loss in attraction in science is attributed to theoretical outdated curriculum that lacks relevance, enjoyment, -curiosity, cultural-social-historical dimension, difficult untrendy content that requires hard work, concentration and intellectual effort which is not part of the current culture, lack of qualified teachers and new set of role models created in media as opposed to scientists and engineers previously seen as heroes and role models (Sjøberg, 2001).

Hudson (2015) observed that often teachers do not do in laboratories what they say they will do. Many teachers are bent on instructor-dominated or lecture-method approaches to teaching and tend to view certain levels of participation in science learning from pupils as interference (Hofstein, 1982). Furthermore, science education has been criticized as a traditional and old fashioned body

of authoritative and unquestionable knowledge filled with repetition that encourages rote learning without deeper understanding and meaning in daily life (Sjoberg, 2001). He recommends reformed curriculum, content, teaching methods and organization of learning processes. A study conducted to find how different school factors affect education outcomes concluded that school managers should focus attention on improving not only the quality of teachers and teaching materials, but also the social environment at the school in order to stimulate more student effort (Hopland, 2016). To find the factors that influence students' manipulative skills during transition from primary to secondary school, namely the teacher, the performance of the students, teaching and learning aspects and the physical environment of the laboratory a study was conducted. The results suggested that primary school students need to be exposed to these skills in using scientific apparatus so that when they enter secondary school, attention can be given in improving and strengthening those skills. Incompetence in manipulative skills in science at primary level may impede science learning at secondary school (Fadzil, Dec 2014).

Findings in an in-depth qualitative study conducted during transition from primary to secondary school indicated that students' cognitive knowledge did not reflect their true ability in manipulative skills. The study also concluded that lack of exposure to practical work in primary schools leads to incompetency in manipulative skills and students may carry this problem with them to secondary school. Manipulative skills during transition can be described by understanding technical skills and functional aspects of performing laboratory tasks. (Fadzil, 2014).

2.3 Challenges of Science in Girls' Schools

Science is often criticized for its lack of relevance and deeper meaning for the learners and their daily life. It does not meet the students' needs for meaning and relevance. The content is often presented without being anchored to social and human needs, neither present nor past. It is often seen as demanding and difficult. The ideas are not always easy to grasp, and their understanding often requires concentration and hard work over a long period of time. The youth of today are not used to cope with such demands (Sjoberg, 2001).

Brotman (2008) asserts that girls have poorer attitudes towards science and lower levels of participation in science subjects. Women are therefore underrepresented in the science work force. To correct this problem, he suggests that girls should be provided with more access to science experiences. He cites inequitable classroom situations in that girls manipulate laboratory equipment less frequently than boys.

According to a study carried out to find the challenges of educating girls in Kenya, several factors were found to interfere with girls' education. These factors include in school factors such as sexual harassment, gender, stereo-typed learning materials, and high rates of repetition for girls and inadequate sanitary facilities. Out of school factors include social cultural practices like early marriages and female genital mutilation, low social economic status of girls and women, poverty, unequal labour burdens between boys and girls. For girls to attend and achieve well in school, there is a need for adequate and appropriate physical facilities, gender sensitive learning materials and teaching practices (Files, 2005).

2.4 Theoretical framework

2.4.1 Theories of Science learning environments

In a study to discover students' perceptions of the actual and preferred laboratory learning environments, it was found that an increase in teaching resources and a change in management practice would help improve the investigative approach in learning science. The instrument used in this study considered the following five dimensions as important in unique science laboratory environments; teacher attitudes and behavior, content and nature of laboratory activities, instructional goals, social variables and availability of space and materials (Kwok, 2015).

Effective teaching approaches which aim for learners' conceptual change requires learning environments that are sensitive to their needs, feelings and ideas. Learning environments with high levels of personalization, involvement, order and organization, and task orientation promote cognitive and effective outcomes. Effective learning is positively related to the levels of cohesiveness and satisfaction in the classroom thus teachers must create an environment where learners perceive it positively and feel confident to express and discuss their opinions freely (Wahyudi, 2004).

The term learning environment relates to the psychology, sociology and pedagogy of the contexts in which learning takes place and their influence on pupils' achievement in the cognitive and affective domains. It not only includes physical activities in the classroom, but also teaching methods, the type of learning in which pupils are engaged, and assessment methods. (Doppelt, 2008). A learning environment therefore is a collection of resources and activities for learning which is deliberately curated with specific knowledge and skill development in mind. (Lombardozzi, 2015). Lombardozzi further explains it as a collection of resources and practices

that enable the development of knowledge and skill, activities and interactions that promote learning and growth.

Learning environments involve the dynamics and interactions between the learner, the teacher and other learning professionals, content and facilities and technologies (Dumont, 2010). Dumont further says that a conducive learning environment has certain characteristics that include recognition of the learners as its core participants, encourages their active engagement and develop in them an understanding of their own activity as learners and encourage learners to be self-regulated. The learning environment is founded on the social nature of learning and actively encourages well organized cooperative learning. It is sensitive to the individual differences among learners such as prior knowledge, ability, conceptions of learning, learning styles and strategies, interest, motivation, self-efficacy, beliefs and emotion backgrounds. The challenge is to manage the differences and ensure they learn together with a shared education and culture. A learning environment devises programmes that demand hard work, effort and challenge from all without excessive overload, enhances knowledge construction not knowledge acquisition. It operates with clarity of expectations and deploys assessment strategies consistent with these expectations. It should give formative feedback to support learning- giving substantial, regular and meaningful feedback. It strongly promotes horizontal connectedness across areas of knowledge and subjects as well as to community and the wider world. It should work in tandem with influences and expectations from home as well as provide meaningful real life experiences.

According to Partnership for 21st century skills (2007) learning environments are the structures, tools and communities that inspire students and educators to attain the knowledge and skills the 21st century demands of us. To teach 21st century skills, learning environments should take care of physical infrastructure that support learning and provide emotional, social and physical wellbeing of the student (Sharon P, 2010). For learning environments to be judged as truly effective, they should define the following education agenda; learning-centered as the critical role of teachers and learning professionals, structured and well designed with careful design and high levels of professionalism leaving ample room for inquiry and autonomous learning and personalized to the needs of learners including the weakest of learners. Further, a powerful learning environment is characterized by a good balance between discovery and personal exploration, systematic instruction and guidance while being sensitive to individual differences of learners. It should prevent a cognitive overload and induce germane cognitive load that facilitates learning and gives

techniques that are not only highly effective in fostering conceptual understanding but also encourages scientific reason (Dumont, 2010).

Each teacher should create or build for the learner an effective learning environment that enables and encourages learning. This environment should be appropriate to the context in which they are working, the nature of activities conducted, the expectations of the teacher and learner and the nature of assessment (Lombardozi, 2015).

Students prefer an environment with more teacher support, student cohesiveness and more investigation and greater co-operation. It is the actual learning environment that shapes and influences a student attitude towards science and scores in examination. Teacher and learning practices should be enhanced to provide more support and give clear direction (Wahyudi, 2004)

Several studies have pointed towards the influence of classroom environment as a significant determinant of attitude towards science. Positive attitudes are associated with a high level of involvement, very high level of personal support, strong positive relationships with classmates, and the use of a variety of teaching strategies and unusual learning activities (Osborne, 2003).

Most studies concentrate on teaching skill and administration matters not on learning environment even if it is known that classroom environment determines school achievement and should be taken into account (Wahyudi, 2004)

In terms of physical space, learning environments should be adaptable and facilitate collaboration, interaction, information sharing, are accessible and open to the larger community surrounding the school (Sharon P, 2010)

According to Sharon (2010), teachers benefit from an up to date in class and virtual technology tools and resources that connect with deeper ways of engaging with content. These tools are not separate from other pedagogical activities but are integrated into the teaching and learning process. She further says that the people network in the learning environment should be empowered to prepare students with the essential 21st century knowledge and skills necessary to succeed in life, career and citizenship.

2.2 Conceptual framework

Consideration of various aspects of science learning environment should be made to guide the design and implementation of lessons in a science teaching environment. Teacher content knowledge, clear understanding of effective instructional practices and pedagogical content knowledge are needed. An environment conducive to science learning motivates learners and stimulates scientific thinking, takes care of social interaction, is varied according to learners needs and falls within syllabus directions. It should communicate clear goals for pupil learning and allow pupils to have input into the goals.

Science teaching should improve learners' motivation and raise interest in studying science by providing a supportive social context to help pupils feel accepted, cared for and valued. It has an ability and willingness to allow for different cognitive styles and ways of engaging with the learning process among pupils, through multiple exemplification, and the use of different types of illustration and mode of presentation, and offering pupils a choice from a menu of possible ways of engaging and a willingness to take into account pupil circumstances and to modify, pace or structure learning tasks accordingly (Osborne, 2003). The nature of in-class activities was identified by Osborne as a factor that was responsible for student choice or non-choice of the sciences while running well-ordered and stimulating science lessons was identified as a factor that enhances good teaching.

Hudson (2015) describes science teaching as an action-oriented approach to science learning and suggests students engaging in and developing expertise in scientific inquiry and problem solving, and developing confidence in tackling a wide range of real world. He then suggests that action-oriented and issues-based curriculum can be realized by applying his 3-phase approach: (i) modeling – the teacher demonstrates and explains the desired behavior, and provides illustrative examples; (ii) guided practice – students perform specified tasks within an overall action strategy with the help and support of the teacher; and (iii) application – students function independently of the teacher.

Science teaching activities need to enable students to interact intellectually as well as physically, involving hands-on investigation and minds-on reflection (Hofstein, 1982). Learning should elicit students' prior knowledge in order for them to connect new knowledge with pre-existing knowledge thus understanding new knowledge better.

Teaching requires adopting a learner-centered pedagogy which recognizes that students must be responsible learners in science (Sjøberg, 2001). Meaningful experiences that engage students intellectually are included while presenting opportunities for learners to make sense of the ideas they have encountered and explored in life. The position of a teacher is to provide an education in alignment with the syllabus that outline how curriculum can be implemented. The syllabus and the school policy outline what to teach as well as discipline and behaviour management within the school environment. The teacher should become very familiar with the presiding science syllabus and behaviour management policy, both of which will help to design learning environments (Hudson, 2015). An in-depth research is suggested (Handre, 2010) to find out teachers' professional experiences, content and pedagogy that are essential to identify the features that most effectively promote outcomes that address both students' and teachers' needs. Information from this research can explain how learning environment interact with individual and group differences to optimize design of existing future opportunities (Handre, 2010). Further, Handre asserts that teacher professional development should build in-depth knowledge and skills in order to promote teaching practice.

As students learn cooperatively with each other, they develop positive social interactions and interdependence with both group processing and individual accountability. Students need to learn how to work collaboratively hence assigning roles and responsibilities to a student or groups of students allows them to successfully complete any given task. In the process of this interaction, students can construct knowledge together by checking their knowledge and understanding with others. The organization of learning environments reflects the teacher's plan, which includes theoretical underpinnings such as constructivism, teaching approaches, resources such as equipment and technology, and locating the activities. Effective teachers vary these environments according to students' needs and the type of activities required. A learning environment can help to motivate the student and stimulate scientific thinking. This achieves the desired outcome of teaching and learning, that is, grasp of concepts, interest and motivation, scientific practical and problem solving skills and scientific habits of mind (Hudson, 2015).

Given the aforementioned aspects identified by Hudson (2015), to solve the problem in relation to teaching and learning we needed to i. identify the relevant materials and instructional media needed in the Science laboratory; ii. clarify the type of student relationships that should be fostered in the Science learning environment and specifically in the laboratory; iii. specify the

Science learning targets needed in each class so that it is clear to all teachers and; iv. determine the knowledge and skills gaps that exist in the primary section of Borough School. Since the lab is a place of social interaction for students with themselves and their teacher, it should be a good environment for such interaction that offers different learning styles and cognitive abilities. Resources should be committed to create and provide support for teaching and learning these subjects. Viable laboratories should be designed to accommodate a variety of projects, innovative research studies and teamwork (Hofstein, 1982).

2.6 Summary of the chapter

This chapter has presented the background literature and covered some theories that have been written on science, theories of science learning environments, challenges of Science with a focus on girls, the significance of the investigation and the conceptual framework for science learning environment.

Chapter 3: Research Methodology

3.1 Introduction

The aim of this chapter is to present the research methodology, ontological foundation, research approach, participants, data collection and data analysis methods.

The aim of this research was to investigate how to improve the Science learning environment to foster teaching and learning. This included finding ways to address the deplorable state of the Science room so that items are stored well and teachers can prepare for experiments comfortably through improving the instructional, infrastructural, and procedural and support materials.

3.2 Ontology and epistemology

In this research, subjectivist ontology was used. This involves looking inside, through direct experience, in order to understand and explain the reality through the eyes of different participants. This ensures integration of personal experience during the research in order to intervene in the problem area to achieve improvement and change (Mack, October 2010). This approach abandons scientific procedures of verification and results cannot be generalized to other situations but it creates local theories for practice. It is subjective since my values and opinions as the researcher may influence the outcomes of the research.

The participants and I made an interpretation of what we saw and understood resulting in multiple views of the problem (Interpretivist epistemology). Our interpretations cannot be separated from our own backgrounds, contexts, and prior understandings. (Creswell, 2007).

3.3 Research approach

Qualitative research approach was used. Qualitative research is a situated activity that locates the observer in the world in order to study things in their natural setting attempting to make sense of phenomena in terms of meanings people bring to them. It consists a set of interpretive material practices that make the world visible, which transforms the world into a series of representations including field notes, interviews, conversations, photographs, recordings and memos to self. Researchers collect data in the field under the natural setting from multiple sources. Inductive data analysis methods are used in this interpretive enquiry where researchers make an interpretation of what they see, hear and understand. The interpretation cannot be separated from the background, history, context and prior understanding of the researcher (Creswell, 2007).

3.4 Operationalization of science learning environment

To measure the outcomes, students' and teachers' questionnaires and interviews were used to collect data. Data from these instruments, observations and field notes were all be analyzed to make an argument about the outcomes of the study. For each aspect, the method of measuring is indicated in the table below.

Aspect	How to measure
What student materials and instructional media do we need for Science in the laboratory?	Availability of books, type of books needed, quality of books, quality of laboratory equipment, which equipment exist and which do not.
What student relationships should we cultivate in the Science learning environment?	Openness in interaction between teacher and students, openness of interaction between teachers, openness of interactions between students, frequency of interaction between teacher and student, frequency of interaction between teachers, frequency of interaction between students, what teachers and students discuss about during interaction, what teachers discuss about during interaction, what students discuss about during interaction
What Science learning goals should we set for our students in each class?	Availability of teaching plans and resources, availability of schemes of work with clear targets for each class, use of schemes of work Pictures, narrations, observations
Which knowledge and skills gaps exist in the primary section of Borough School?	Teachers trained in science knowledge, type of training needed to deliver science effectively, type of training science teachers have, kind of extra training needed

In my case, I collected data through interviews, questionnaires, observation and descriptive information of participants about the natural science environment setting of Boroughs School in a bid to further improve it.

3.5 Methodology

Case study research methodology was used. A case study is a qualitative research approach in which one or a few instances of a phenomenon are studied in depth (Given, 2008). It is a form of qualitative analysis that involves observation of a social unit where an in-depth study, full analysis or an intensive investigation is carried out to locate the factors that account for the behavior and patterns of the unit (Kothari, 2004). It involves an in-depth exploration of a bounded system based on extensive data collection (Creswell, 2007). Case studies allow for observation in real contexts and reflection about the characteristics of an individual unit, institution or social unit (Yin, 1994) all with the aim to solve this problem. This approach not only creates knowledge and understanding but also sets a standard for good teaching practices through development and implementation of policy, and gaining experience through exposure to a particular phenomenon. Case studies are sources of theoretical innovation and with its descriptive goals-interpretive goals with their analysis, it is concerned with pinning down the specific mechanisms and pathways (Given, 2008) between cause and effect. This type of research investigates and reports the complex dynamic and unfolding interactions of events, human relationships and other factors in a unique instance (Cohen L, 2007).

In my case, the real context was Borough School and reflects on the characteristics of the science learning environment so that I could expose the then current phenomena and improve it further. I needed to immerse myself into the science learning environment to understand how it affects the learner as well as the teacher. This case study allowed me to gain a deep understanding of all the factors that were at play in Borough's situation. Since this was education research, it was also important for me to use an approach that would provide teachers with experience, so that they may become knowledgeable and adequately prepared to handle a variety of situations in the classroom (Mills, 2010)

3.6 Participants

This study involved all the ten science teachers in the school, two non-candidate pupils from different classes and an external science teacher. The two pupils were chosen out of convenience, they were available and expressed willingness to participate. They are the ones whose parents

allowed them to participate in the research. The external science teacher was not part of the teaching staff of Borough School but her services were sought in order to have an external eye, to ensure we kept within what was accepted other schools too. The pupils and teachers assessed the suitability of the room at the onset of the research and suggested changes to improve it. I used purposive sampling to select these participants. This choice was based on the fact that I wanted to discover, understand and gain insight of the situation on the ground hence I chose the sample which would lead to most understanding (Creswell, 2007). At the end their opinion on the suitability of the improved room was sought. The science teachers in the school assessed the requirements to make the place a suitable tool for teaching and learning, they developed the suggested materials and also the suitability of the room at the completion of the research.

3.7 Data collection and presentation

In the first stage of the research, teachers and pupils gave their written accounts at different times. I first explained to the teachers my desire to carry out the research. I then asked them to help me locate the aspects that would lead to the improvement of the science laboratory. After analyzing the information received from the teachers, I sought the learners input but in their case, I gave some headings to keep them within the scope of the research. In stage two of the research, the different instruments were administered concurrently as I thought appropriate.

In case studies, data is collected in the field at the site where participants experience the problem under study. The researcher is the key instrument that gathers information using multiple sources of data including interviews, observation and other documents without referring to a single data source. (Creswell, 2007). In this study, I collected data in Borough school, particularly in the science laboratory and the classrooms before any materials were bought and after obtaining the materials and tools for teaching. Images and textural data was collected from the observations, interviews, and various documents already mentioned.

Data was collected using four areas developed from the research questions; i. identifying the relevant materials and instructional media needed in the Science laboratory ii. clarifying the type of student relationships that should be fostered in the Science learning environment and specifically in the laboratory; iii. Specifying the Science learning targets needed in each class so that it is clear to all teachers and; iv. Determining the knowledge and skills gaps that exist in the

primary section of Borough School. Data collected from both the teachers of Science and the students addressed similar areas to enable triangulation.

Data was analyzed to identify the relevant student media and science materials needed, to clarify the type of student relationships that should be fostered in the Science learning environment and specifically in the laboratory, specify the Science learning goals so that it is clear to all teachers and to determine the teachers' knowledge and skills gaps to ensure learning occurs in a constructive manner with clear assessment expectations.

In this research, data collection methods included face to face interviews, questionnaires, class observations, journals, letters, photos and field notes.

3.7.1 Class observations

As stated by Creswell (2007) during observations the researcher observes participants in the natural setting while taking notes on behavior and activities of individuals in the site. This way the researcher has firsthand experience as she records information as it occurs although they may be seen as intruders in the lesson. Interviews elicit views and opinions from participants and allow the researcher to control the line of questioning while getting a view of emotion and feeling. Documents give the researcher participant language and words and are an unobtrusive source of data which represent thoughtful data which needs no time to transcribe. These documents pose a problem of being incomplete and may not be authentic or accurate. Audio visual materials capture attention visually thus sharing reality directly while being unobtrusive. These can be difficult to interpret and the photographer may disrupt and affect responses (Creswell, 2007).

During classroom observations, firsthand information was collected by observing both the learners and teachers' behavior. An external science teacher and I observed three different classes when teaching and learning was ongoing. Our aim was to find out how the teachers and pupils interacted with each other as they manipulated the science tools and equipment. We observed the activities in the classroom as the teacher used the procured materials for teaching as well as the activities of the pupils during learning and as they followed the teacher's instructions. Collected information was written following the observation guide including demographic information about the class, time, teacher and observer.

3.7.2 Face to face interviews

I had prearranged meetings with three participant teachers of the science panel where I asked them open ended questions and recorded their responses. The respondent was free to state the answer as they found appropriate although I used the interview guide. I then transcribed the data collected from this for analysis. This enabled me to get information from participants that I could not observe directly as well as have control over the type of information received. I asked specific questions and could probe for details and rephrase the questions to shed more light if a response was unclear. Data from this source could be deceptive and my presence could have affected how interviewees responded (Creswell 2007). To improve the results from this source, interviews were done after class observations in order to compare the information. Clarification was sought for whatever was found to be off the line or farfetched from the interviewee.

3.7.3 Open ended questionnaires

A few open ended questions aligned to the research questions were designed and a blank section left for the respondent to write an answer for each question. No standard answers to the questions were expected hence no boxes were left to tick; instead, string responses were expected to find out what the participants thought about what was asked. All the participating teachers and pupils responded to the questions and handed in the questionnaires. The questionnaires collected preliminary data that was needed in research questions 4.

The journal, photos and some field notes were done by me. Participating teachers and students gave the written accounts. The letters were written by the school.

Journals are valuable qualitative tools that track participants' activities and objective experiences (Creswell 2007). They capture emotion introspection and self-reflection. These were very useful as I could refer to them whenever I had a doubt even long after they were written.

Photographs acting as data are produced by the researcher or the research participants, they act as stimuli and can be pre-prepared and introduced by the researcher into the research situation. Field notes include written descriptions of what was observed as well as documents or other objects gathered while observing. They can be used by participants to express emotions and to develop concepts or directions related to the problem (Given, 2008).

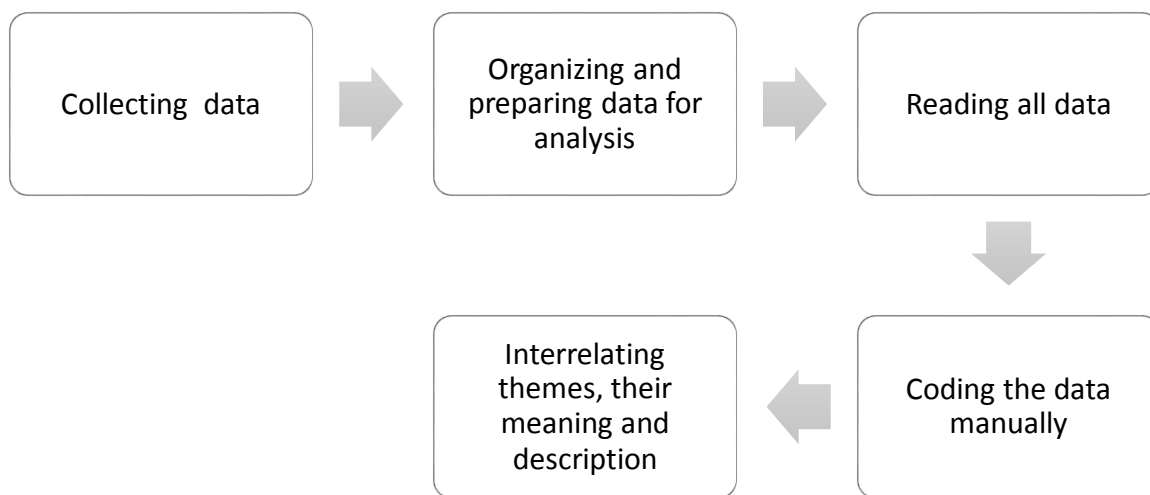
As has already been mentioned in chapter one, this research was carried out in one school. This was because a similar school in terms of constitution aims, ethos, and gender does not exist in the west lands sub county or anywhere else in the country. This School was of primary concern to me as a researcher. I needed to carry out an in-depth investigation for this school of creating a conducive learning environment that will yield greater information to others interested in the same

3.8 Data analysis

According to Creswell, data analysis involves making sense out of text and image data. In this research, it was an ongoing process involving continual reflection about data conducted concurrently with gathering the data (Creswell, 2009).

From the teacher and student responses and classroom observations, I developed categories which were coded using my own scheme without being guided by any other existing one. This was because new categories kept emerging and it was difficult to keep the responses within a specified guide.

The illustration below shows the process of analyzing textual data in this research.



Source: (Creswell, 2009)

The above illustration shows that data was analyzed by evaluating the responses of the participating teachers and observing changes in the science room and classrooms. This was done by content analysis in order to reduce the amount of written data to manageable and comprehensible levels. Content analysis is a research technique used to make replicable and valid inferences by interpreting and coding textual material. Coding involves the process of organizing the material into chunks or categories and giving them a term called a theme (Creswell, 2009). The process was followed although not in that strict order since as already mentioned earlier data was handled as it came making it a continuous process.

Texts such as documents, oral communication, and graphics was evaluated systematically and converted into quantitative data. A detailed description of the setting was done, followed by a systematic analysis of data for themes and finally interpreting the meaning of the themes before writing the report (Cohen L, 2007).

3.9 Validity and credibility

Validity is necessary to demonstrate the accuracy of findings and convince readers of this accuracy (Creswell, 2009). To add the validity of the study, I used different sources of information. I examined evidence from the many sources and used it to build a coherent justification for themes. Themes were established based on converging several sources of data or perspectives from participants together with using rich, thick description to convey the findings (Creswell, *Research Design: Qualitative, Quantitative and Mixed Approaches*, 2009). As this research was concluded by putting interventions (transformations), the final findings were taken back to participants and the school who determined their accuracy. Peer debriefing by a colleague and constant observation enhanced the accuracy of the accounts throughout the study (Yin, 1994).

3.10 Ethical considerations

In data collection and analysis, I observed a number of ethical considerations. I sought consent from teachers to get information from them on how to improve the science learning environment as well as from parents of students involved in the study and informed them that they are free to participate and withdraw (Yin, 1994). While conducting the study, I informed participants about how the information collected will be used. Photographs are blurred in instances where it may be possible to know the identity of individuals. I fictionalized the name of the school to prevent any possibility of the school being identified. Peer review/debriefing provided an external check of

research process thus keeping the participants honest (Creswell, 2007; Given, 2008). To increase its trustworthiness, I used multiple sources of data to confirm findings and the descriptions were written after confirming that the interventions are satisfactory from both students and teachers.

3.11 Summary of the chapter

This chapter has presented the methodology used in this research. In particular, the choice of participants, data collection methods and data analysis. the validity credibility and ethical considerations made during the study have also been addressed. The following chapter will present the results or the findings of the study using my own procedure of presentation.

Chapter 4: Presentation of Research Findings

4.1 Introduction

This chapter covers the presentation of research findings based on the data gathered from stories, direct observations and interviews of this study. Themes were identified and coded manually according to the stories written by different participants. These were provided in sequence. The themes were structure of the room, pedagogy, instructional materials, and use of instructional materials, challenges in processing learning goals and the knowledge and skills of the panel members. This chapter responds to the research questions listed in Chapter 1.

The first section presents data related to the first research question: What student materials and instructional media do we need for Science in the laboratory? This question was informed by the items listed in the curricula and the comments given by the teachers. This covered such aspects as the room that serves as the science laboratory as well as the materials necessary to facilitate teaching and learning.

The second section corresponds to the second research question; What student relationships should we cultivate in the Science learning environment? this question sought to investigate how interactions between students and teachers, teachers and teachers and students and students can be fostered in the physical laboratory. The interactions were observed during the use of the instructional materials availed in the laboratory.

The third section addresses the third research question; What Science learning targets should we set for our students in each class? Although course content goals are stipulated in the syllabus, I, together with Science subject teachers, found specific targets which should be set in the schemes of work in relation to teachers' and curricula needs. All this was geared towards improving each other's competency in teaching of science. Each learning target was aligned to specific science equipment that was availed.

The final section presents data related to the fourth research question; Which knowledge and skills gaps exist in the primary section of Borough School? This question related to the teachers of science in the school. The data addresses their teaching experience, their current knowledge and skills depending on the educational level as well as what else is required to improve the skill level. The aim of this data was to find out what knowledge is required in the syllabus, vis-à-vis what the teachers have to find out if there are any gaps in knowledge and skills and how to bridge the gap.

4.2 Instructional materials and media

Students need various materials such as books, laboratory equipment, teaching charts, chemicals for experiments and real things for learning purposes. Teachers also need the same materials as well as instruction media to be able to guide students effectively. Most of these are stored and manipulated in the science laboratory. When learners' accounts were analyzed, it was found that most of them were not available in the existing laboratory and if available, they could hardly be used inside the room due to its dilapidated state. The accounts were written by the learners at the very beginning of the study and the information collected was extracted and analyzed immediately by comparing what both learners wrote. This subsection gives the results in themes from the students and teachers accounts.

Students' responses

The study sought to find out the student's opinion on the requirements that would make the science lab an effective tool for learning. The following themes were found.

1. Structure of the Room

The room was in a bad state at the beginning of the study. This condition of the room was mentioned by both teachers and students as important in the science laboratory. From the pictures taken at the onset of the study, this room needed improvement to take care of material order of the room and working conditions for both teachers and learners. The presence or absence of these subthemes interfered with how the participants worked and the maintenance of the instructional materials that were eventually procured. Several subthemes were identified;

Ventilation

There was a general feeling that the windows need to be adjusted properly to allow for ventilation and lighting. Although only a few structural adjustments were allowed by the school, a student mentioned that "*the room needs more windows*" for ventilation purposes as well as lighting.

Safety

Before the intervention, the wooden door of the room was broken and had been attacked by termites due to negligence. One of the students stated that "*the door seems to be falling apart*" further suggesting that "*the door should be repaired ensuring that it opens to the outside to ensure safety of those working in the lab*".

Working spaces

It was suggested that working spaces should be provided. One student was of the opinion that *“it would be appropriate to have long tables and lab stools for students’ use in the lab”*

Storage

The students are aware that there are many materials that need storage. They recommended that *“cabinets and shelves on one side of the room would be helpful to store books and lab supplies”*. Another one felt that *“there is absolutely nowhere to store things and what is needed may be is some cupboards, shelves...”*

Pedagogy

An open student’s forum gave some insight on what teachers need to do to improve teaching and learning in the school. Teachers play a vital role in the lesson and how information is delivered determines students understanding of content and how they will process information. The following subthemes were identified;

Activities

Teachers should *“make the classes more interesting”* by taking them outside for practical learning using previously collected materials. Teachers need *“to make charts that will make the topics easier to understand and can be used when students are revising for exams”* and *“to bring real materials to class as they have not been doing so”*.

Explanations

To make a lasting effect on the learners, students suggested that teachers, *“should do experiments in class and not just explain the experiments”*. This method of explaining experiments is preferred by many teachers as it requires very little effort on the part of the teacher. Students’ statements show clearly that they do not benefit from this method.

Problem based learning

For their revision, the students are required to study the whole primary school syllabus which is voluminous to say the least. Teachers should help their students in this area by doing “*a summary of each topic should be done after teaching the topic*” and “*Go through frequently failed KCPE questions.*”

2. Instructional materials

The room would have been of little use without science teaching resources. This theme was of utmost importance because it related directly to research question one. Learners needed to manipulate these materials for proper engagement and interaction. The following subthemes were found;

Teaching aids

The students identified visual aids as important for their learning. In the students’ discussion, it was suggested that visual aids for all classes should be obtained and good projects done by students should be preserved for this purpose. “*These projects preserved from the current and past students encourages most pupils and inspires others to try and improve their own*”, observed one student. The same student commented, “*I highly doubt anyone can forget things after being taught with these instruments*”

Table 1 Relationship between items of students’ interest and student Instructional materials

Item	Frequency of item	Mentioned by	Linked to Research Question	Linked to another aspect/item	Linked to which sub-aspect of the aspect identified
Ventilation windows	2	student 1, 2	1	Physical structure	Air quality
Doors	1	Student 2	1	Physical structure	Safety

Working spaces	2	Student 1, 2	1	Physical structure	Enables independent work
Storage	2	Student 1,2	1	Physical structure	Order
Space	2	Student 1,2	1	Physical structure	Movement of pupils
Pedagogy	2	Student 1,2	3	instruction	Teaching skills
Charts	2	Student 1,2	1	Instruction materials	Teaching aids

Teachers' responses

The study also sought to find out the teachers' opinion on the requirements that would make the science lab an effective tool for teaching. The following themes were found.

1. Structure of the room

The science teachers had for a long time wanted a place where they could carry out experiments. At the beginning of the study, some teachers openly said what needed to be done while others were not so open with information because they felt it meant too much work for them. In the end the following subthemes were seen;

Space

This aspect was mentioned as a problem by all the respondents in different ways, the room was said to be "tiny", "not spacious", "space is limited", and "should be very spacious". For this reason, teachers do not use this room for teaching even though the room is located at a good place near the classrooms.

Ventilation, working spaces, storage space, lighting.

All respondents said the room is poorly ventilated, poorly lit, has no space for display and lacks necessary furniture required in a science lab. One teacher said that "*the ideal science room should be spacious, well lit, well ventilated, with enough working spaces, tables, stools and cupboards for storage of materials*".

Importance of Science Room

Teachers agree that the science room is an important room for teaching and learning, with one respondent commenting that it is important for “*carrying out experiments, proper and fast syllabus coverage, exposure and hands on experience for students, easy reference to previous work*”. The room has not been used as it should have due to the many shortcomings stated above.

In conclusion on instructional media and materials;

It is worth noting that several of the responses given by the students were also given by the teachers. All the themes reported in this section were mentioned by two or more participants as can be seen from tables 1 and 2.

2. Instructional materials

Teachers said that the room was poorly equipped for science practical yet it was an important tool for teaching. While explaining the requirements, one teacher indicated that teaching aids were needed to enhance teaching. She said, “*A projector and screen would play a great role in showing of video clips when teaching*”, while another was not so specific but pointed to the lab equipment by saying that “*the lab should be equipped with basic equipment for science teaching*”.

Table 2: Relationship between items of teachers’ interest and student Instructional materials

Item	Frequency of item	Mentioned by	Linked to Research Question	Linked to another aspect/item	Linked to which sub-aspect of the aspect identified
Ventilation windows	7	Teachers	1	Physical structure	Air quality
Room space	7	Teachers	1	Physical structure	Movement of pupils
Working spaces	6	Teachers	1	Physical structure	Enables independent work
Storage	1	Teachers	1	Physical structure	Order

Lighting	2	Teachers	1	Physical structure	Energize, alertness
Safety materials	2	Teachers	1	Materials	Accidents

4.3 Relationships

To investigate how interactions between students and teachers, teachers and teachers and students and students can be fostered in the physical laboratory, observations were made during the use of the instructional materials availed in the laboratory. The following themes were identified;

Trigger/engagement

The students were found to be completely engaged during the lesson and were orderly and attentive in the lesson. They constantly talked with each other as they manipulated the materials repeating what the teacher had explained or demonstrated. The participants made comments such as, “*students were eager to touch the materials*”, “*they constantly talked to each other as they worked with the things*”, “*the girls were so excited to touch the equipment*” and “*pupils discussed in their groups and found the teaching aids interesting*”.

Use of instructional materials

In class, the teachers observed “*explained the topic using available resources and allowed students to work with the materials*”. After the explanation, students were expected to work “*independently as the teacher went round discussing relevant content as the pupils worked*”. Several students asked questions to which the teacher responded satisfactorily. Both students and teachers discussed matters excitedly. One observer wrote that “*students’ curiosity was aroused, they wanted to touch the things and asked a lot of questions. The teacher explained clearly and the girls seemed to be satisfied*”. This open communication was seen in all the classes observed. The pupils were disappointed that the lesson ended so soon, yet there was so much they needed to know and do.

Group activities

In a different class, students discussed in their groups as they did what the teacher asked them to do. From an outdoor class, a participant commented, “*pupils were free and relaxed in the outdoor lesson. They observed the materials in groups and were quite curious as they had not seen any close up of the materials*” They found the lesson very interesting, showing eagerness to learn and handled the materials with curiosity.

Working with resources

When allowed to use the available resources, students were so excited to handle the equipment. *“They observed, touched and worked with them throughout the allowed time”*, wrote one observer. From the question that were asked, it was clear that the students were seeing those things for the first time.

Discussions

From their conversations, they are motivated to know more about the materials they were handling and a keen eye observed that *“they understood better”* what was taught. In our meetings, *“students’ dialogue”* was found to be important in the science laboratory as it enables communication” talking”, *“sharing of ideas”* and instructions

Meetings

In the course of the research, the science panel held several meetings to discuss the process of teaching as was necessary to come up with the database. At the beginning of the research, some teachers in the science panel never wanted to participate and did not sign the consent form. There was a change of heart when the lab started taking shape. They signed the forms and started giving ideas. One such teacher warmed up and told me, *“Originally I was very negative. I thought you were just increasing our work and I never understood how it would help”* In these meetings several things related to the study were discussed, as each teacher tried to understand what their contribution was as well as how they could be helped or help others. In one of the meetings, one teacher said, *“I could not believe it when I saw ‘the ball and ring’ I have never seen it myself leave alone the students”*. After this comment, we agreed to *“have another meeting to discuss how each item in the lab would be used during teaching and iron out all challenges”* as one teacher put it. Although the research was very involving, in the end many teachers felt *“helped by the many discussions we have had as a panel and understand some topics a lot better”*

Class observations

One of the aims of the study was to help to improve each other’s competency. To fulfil this need, each teacher had a critical friend who observed their lesson with the aim of learning from her as well as giving feedback on how to improve their teaching. I interviewed one young teacher who asked me *“can I invite you teach for me heat transfer while I observe?”* During our discussions it

was apparent that teachers find the topics related to physics “*very challenging and difficult*” to teach.

Consultations

After the original go slow was over, teachers worked consistently well, as a team, consulting with each other and discussing difficult topics throughout the research period. They shared the different ways they approach topics, especially the practical approach. During the process of transformations, teachers consulted each other a lot and were fully involved in the procurement of the laboratory materials. It came out that the ones who had not taught the higher classes needed help and the experienced ones offered the help. In the end teachers learnt a lot from each other and are making every effort to make their lessons student centered as they utilize the newly equipped lab. A senior teacher had difficulties understanding “*some topics and experiments*”. After such comments, it was clear to me that we needed to continuously update our knowledge and our resources.

4.4 Learning goals

Although course content goals are stipulated in the syllabus we found which specific targets should be set in the schemes of work in relation to teachers’ and curricula needs. Each learning target was aligned to specific science equipment that was availed. All this was geared towards improving each other’s competency in teaching of science. At the end of one science seminar we had, one reflection read, “*it would have been difficult for me to use some of those things we bought had we not discussed the experiments per topic*”. Several teachers feel challenged to teach the examination classes, they identified several challenges related to content in the syllabus during our discussions. These were the themes found for this section;

Knowledge challenges

Five (half) of the teachers in the panel felt uncomfortable teaching higher classes (Std 7 and 8) since they did not have “*deep knowledge of the syllabus requirements*”. Two of them have only taught up to Std 4 in their entire career while the other three have taught up to Std 6 but they felt they could not handle a higher class and always requested to be left at Std 6 or below.

Restatement of goals

In one meeting, we agreed to analyze the syllabus together so that we share our experiences. The goals and requirements for each class were restated for all to understand. We looked at the

objectives and put each one into perspective, with each of us noting what was required. All the material was put in a database that is accessible to the teachers. The teacher who had only taught up to class 4 said, *“If there is one thing I find useful, it is the database. I am going to use it a lot with the ICT we are learning”*

Schemes of work

All the topics in the primary school syllabus, schemes of work and teaching plans were written, and stored in the database. The schemes of work are *“very detailed”* and *“difficult to make”* as they entail full preparation including the resources the teacher will need the whole term.

Competency

By the end of the research period, teachers felt more competent to teach any class with the availability of the lab materials. *“With these resources I have everything I need to teach some classes I was afraid of”* said one teacher who has never taught beyond class 4. To ensure that students learn the skills necessary to use in life, specific goals should be set for them to guide their learning.

4.5 Knowledge and skills gap

The data in this section is related to the teachers of science in the school. It addresses the years of experience, their current knowledge and skills depending on the educational level as well as what else is required to improve the skill level. The following themes were identified for this section;

Current knowledge and skills

All of the teachers, without exception, felt they need to improve their skills in order to improve their teaching. The school has provided an in service training (BVATT) in which several aspects of teaching were addressed. When asked to state any extra training they have received in their teaching career, teachers only mentioned BVATT (2015) from which they borrow the skills instilled in this training. The use of ICT in teaching was identified as a real problem by some of these teachers through this comment, *“we need to learn ICT faster in order to use it for teaching without asking for help”*.

Education level

All the teachers in the panel have basic training in science knowledge that was given at teacher training colleges. All the teachers of science except one have only a P1 certificate as the highest

level of training. One of the teachers has undertaken a degree in teaching. It is popular belief in the school that better teaching behavior is related to student achievement in science (and other subjects also). Likewise, the school believes in hiring and developing qualified teachers as well as to enhancing ongoing teacher in-service training.

Table 3 Educational level

Highest level reached	No. of teachers	Percentage %
Degree	1	10
P1	8	80
Other	1	10

From Table 3, all but one teacher have P1 training. One teacher has a bachelor's degree in teaching. It would seem like the teachers have enough education for primary teaching but the skills acquired in this training was sufficient in the past but does not support teaching 21st century skills for today's child. This notion is evident from the teachers' feelings that they "*need to be helped to understand certain topics*" that were last experienced in secondary school. Some topics, especially the ones related to physics have proven to be problematic and teachers requested they are helped to understand them. One teacher also mentioned that she explains the experiments supposed to be done in class because she does not understand them well hence she is unable to guide them through the experiment.

Table 4 Years of experience

Years of experience	No. of teachers	Percentage %
1-5	0	0
6-10	7	70
11-15	1	10
16-20	2	20

From Table 4, most teachers of science in the school fall in the range between 6-10 years of experience. None of the teachers has taught for less than five years. The modal years of experience is 10 years. The years of experience range from 7 years to 19 years. From this data it is evident that the teachers are not young in terms of teaching experience, although this does not mean they

have gained the confidence needed to teach all classes in the primary school as indicated by the next section.

Table 5 Highest level taught

Teaching level	No. of teachers	Percentage %
7-8	3	30
5-6	5	50
3-4	1	10
1-2	1	10

As seen in Table 5, 70% of the teachers have Std 6 as the highest level of teaching. One teacher has only taught Std 2 as the highest class while another has taught up to Std 4. All these teachers (7) feel incompetent to handle the examination class. One of the remaining 30% reached Std 8 this year for the first time after having taught in the school for eight years.

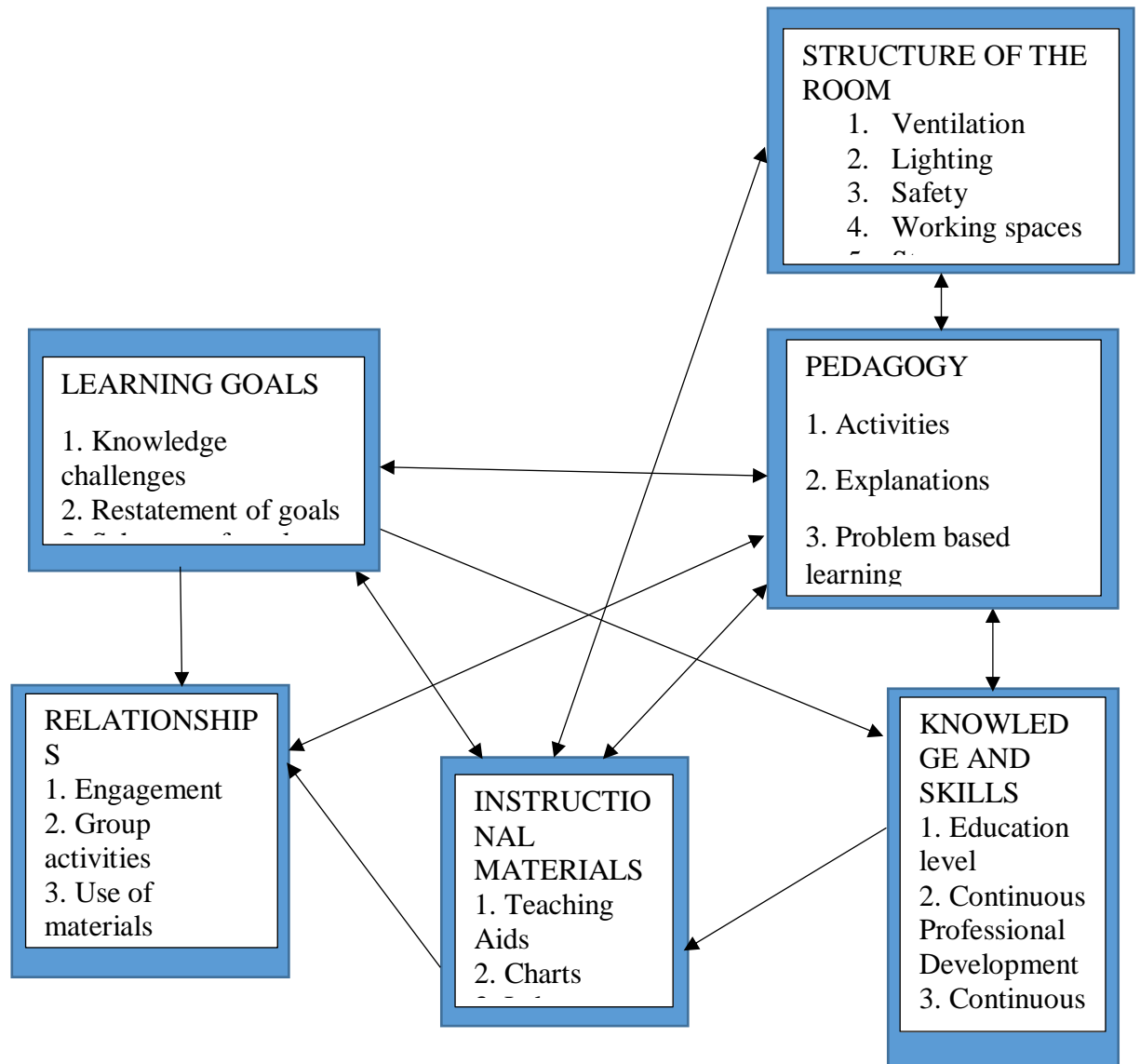
Continuous improvement

In our meetings, teachers felt that they need to continuously update their teaching skills in different ways. One teacher commented that she has learnt a lot from her own teachers just within the period of this study but the rest neither agreed nor contradicted this assertion. One teacher wished we could have “*a resource person every term!*” although she knew this was not possible

Outsourcing CPD

To improve continuous assessment tests and KCPE performance teachers suggested that the school could outsource a science expert from KICD who would train them in assessment and evaluation. One observer commented that the teacher “*needs to expand her ability to make science more practical*” These comments came from two of the teachers’ points on the need for teacher improvement, “to facilitate a science clinic from MOE personnel who is an expert in teaching and assessing science” and “*the school should organize for someone from MOE or KICD on science and iron out grey area.*”

Figure 1 Framework showing the relationship between items in the study



This illustration summarizes the themes found in the research identified as some of the aspects and sub aspects that would foster teaching and learning of science. They were found to answer the research questions for this research and were therefore considered as the critical pillars necessary in the science learning environment for effective teaching and learning.

From the above illustration, it can be deduced that;

- i. A well-structured facility that satisfies the necessary specifications encourages the teacher to plan teaching activities that enhance student relationships. Students will work well in this facility to achieve desired education outcomes.

ii. Pedagogical skills are influenced by teacher knowledge and skills. The explanations given in class are dependent on the teacher knowledge and skills. Student relationships are enhanced when the instruction materials are used by the knowledgeable teacher during teaching. Unless these materials are stored in an appropriate physical facility, their use would hardly influence students' interactions since other factors would negatively influence student behaviour.

iii. The teacher with appropriate knowledge and skills is able to interpret the desired goals. To interpret the syllabus goals and to set appropriate ones per class, the teacher should understand the requirements. Unless the teacher is well skilled, it will be difficult to understand the use of instructional materials whose use encourages student interactions and positive attitudes towards science. The use of instructional materials will be determined by learning goals stipulated in the syllabus and skillfully organized by the teacher.

4.6 Summary of the chapter

In this chapter, the findings of the study have been presented and linked to the research questions. In the following chapter, these findings will be discussed and a conclusion for each research question will be drawn. The items in the framework (figure 1) in this chapter have been used to answer the research questions for this study and have also been identified as the aspects necessary to create a conducive science learning environment.

Chapter 5: Discussion, Conclusion and Recommendations

5.1 Introduction

The purpose of this study was to intensively investigate and locate the aspects needed to make the science learning environment conducive to teaching and learning. This chapter discusses these aspects through some important issues concerning the research questions that framed the study and analytical results mentioned in chapter 4 (with reference to the literature review in chapter 2). It also presents conclusions, recommendations and suggestions for further research based on the findings of the study. Finally, the challenges and limitations of this study are presented here.

Four research questions framed this research. They were answered by themes that emerged from data collected as reported in the previous chapter. These questions are discussed below.

5.2 Discussion

5.2.1 Student materials and instructional media for Science in the laboratory

The study sought to find out the requirements that would make the science laboratory an effective tool for teaching and learning. At the beginning of the study, the existing science room was in a bad state and was poorly equipped. It fell short of the requirements of a teaching environment as was mentioned by the participating teachers. For this reason, it was hardly used for teaching. The analysis results show that both teachers and students agree that the physical laboratory ought to improve to make it an effective tool for teaching and learning. This is consistent with the study by (Colby, 2000) who stated that the quality of school facilities seems to have an indirect effect on learning. It was clear that proper teaching and learning would only take place in an appropriate physical facility that satisfies basic requirements as is also mentioned by (Lombardozi, 2015). This room should be well spaced, well ventilated, well-lit and safe for use for both teachers and students who work in the room. Further, certain provisions are necessary such as enough working space for students as mentioned by Kwok (2015) storage cabinets and shelves as well as places to hang materials being used in the room like lab coats. The literature cited in this study did not specifically mention the aspects (lighting, ventilation, space and safety) of the physical facility that were seen in the actual research.

The research also found that a quality facility is complemented by the availability of materials and instructional media for teaching and learning. This is as indicated by (Files, 2005), who said that there is a need for adequate and appropriate physical facilities, gender sensitive learning materials and teaching practices. The materials recommended in the science laboratory are not gender

sensitive but are useful regardless of the gender using them. Both students and teachers recommended that laboratory materials should be availed to offer hands on experience to students who carry out experiments in the laboratory and use it as a tool for revision for the KCPE. This agrees with Other instructional materials include teaching aids in form of charts and other visual aids including well-made students' projects.

Together with the laboratory equipment, it was suggested that a database with resources for teaching the whole primary science syllabus is availed for reference by all teachers in the panel. This database consists of restated syllabus objectives, schemes of work, teaching plans and notes, suggested activities for each topic, teaching videos and other resources. Although this aspect was not directly cited in the literature review for this study, the participants felt strongly that the resource will be useful for their insights during teaching. This requirement tends to agree w's (2015) and Sharon's (2010) assertion that organization of learning environments should include resources such as equipment and technology, and that effective teachers vary these environments according to students' needs and the type of activities required. With this in mind, the availability of materials has an effect on the planned student activities as suggested in the framework from the results in chapter 4.

5.2.2 Student relationships to cultivate in the Science learning environment

The second research question investigated how interactions between students and teachers, teachers and teachers and students and students can be fostered in the physical laboratory. In the course of the research, positive attitudes and motivation in students were evident in the open communication constantly observed in the classroom as they used the materials and media availed in the lab. Hudson (2015); (Sjoberg, 2001) and (Wahyudi, 2004) support this assertion by encouraging a learning environment that supports co-operation and high level of commitment. In the use of the availed resources in the classroom, teachers explained to students what was to be done later allowing them to repeat and work independently. As the teachers explained, the students were fully attentive awaiting their turn to handle the equipment. The level of involvement was undoubtedly raised in the answering of questions asked by the teacher in class as well as responding to each other's concerns. Students enjoyed their activities while working in their groups; together they handled the materials with eagerness, curiosity and attention. They found the lessons very interesting and were excited to use the materials as they shared what was available. These findings are consistent with the Osborne's (2003) study which mentioned that positive

attitudes are associated with a high level of involvement, very high level of personal support, strong positive relationships with classmates, and the use of a variety of teaching strategies and unusual learning activities. It was observed that students are inspired and encouraged to improve own work by their fellow student's work as seen when student projects were used as a teaching resource in the course of this study. The excitement, eagerness and curiosity shown by the students in the course of the research echoes Hudson (2015) who says that a learning environment can help to motivate the student and stimulate scientific thinking. These findings are similar to several studies that have pointed towards the influence of classroom environment as a significant determinant of attitude towards science.

Throughout the course of the study teachers discussed and consulted with each other while sharing their classroom experiences while supporting their colleagues who are not so confident with their practice. These discussions and consultations indicate an improvement in the way teachers interacted as they worked towards improvement of their own practice. The research revealed that as teachers work together towards a common goal, their relations improve. This finding is unique to this study since the literature reviewed for this study did not suggest this particular result.

In this research, teachers explained to students what to do and went round helping them as they repeated what the teacher had done and finally left them to work on their own following the same process, a strategy similar to Hudson's (2015) 3-phase approach of modeling, guided practice and application as mentioned in chapter 2.

In this study it was seen that students valued working in their groups where they utilized the full period allowed working together as they learnt more with the materials. Spontaneous discussions were evident as they worked with the available equipment, a sign of their support for each other.

Evidently, students found the lessons very interesting, showing eagerness to learn and handled the materials with curiosity. This is supported by the assertion that Science teaching activities need to enable students to interact intellectually as well as physically, involving hands-on investigation and minds-on reflection (Hofstein, 1982).

When observing lessons, teachers allowed pupils to work in groups thus allowing them to learn cooperatively with each other, to develop positive social interactions and interdependence with both group processing and individual accountability as indicated by Osborne (2003). In the process

of this interaction, students can construct knowledge together by checking their knowledge and understanding with others.

5.2.3 Science learning targets set for our students in each class

Although course content goals are stipulated in the syllabus, I, together with Science subject teachers, found which specific targets should be set in the schemes of work in relation to teachers' and curricula needs. Each learning target was aligned to specific science equipment that needs to be available. Several discussions with the teachers of the panel resulted in teachers sharing their experience, teaching and learning from each other depending on the level of competency. Syllabus goals were restated aligning them with the science equipment that needs to be available. Syllabus requirements and targets were also revisited topically all with the aim of ensuring each member of the panel understands what is required of them to achieve expectations. The results here echo Hudson (2015) who says that the teacher should become very familiar with the presiding science syllabus. This requirement was pursued throughout the study in the discussions and consultations of the teachers of science in the school. In the end, as has already been stated, the materials collected were organized and stored where they can be accessed by those teaching science.

5.2.4 Knowledge and skills gaps in the primary section of Borough School

The aim of the fourth research question was to find out what knowledge is required in the syllabus, vis-à-vis what the teachers have to find out if there are any gaps in knowledge and skills and how to bridge the gap. To qualify as a primary school science teacher a teaching certificate from a teachers' college is required having completed the Kenya certificate of secondary education.

All the teachers who participated in this study have basic teacher training given that they all have a P1 certificate. This qualification instils teaching skills but does not teach in detail each and every aspect of the syllabus and the topics therein. From the results of the study, there was a general feeling that even though they are qualified to teach, they need assistance in processing some topics in the syllabus especially those related to physics.

The school on the other hand recognizes the need for further training. Each teacher in the panel has taken the course offered in the school. While teachers continue to borrow from the skills instilled in this course, the generality of the course does not address the specific needs of the science teacher. All of the teachers without exception stated that they needed extra training to address various issues.

The results depicted in Table 4 indicate that the least experienced teacher has seven years of teaching experience. Some teachers have been teaching for more than ten years yet they are not confident to teach beyond class 6. This indicates that they are lacking in a skill that is required to enable them to exploit their full potential and to achieve the expected outcomes.

From the students' perspective, their teachers should include activities that make their learning more interesting by providing materials that enhance their learning. They have seen these materials in the past an assertion that leads to the conclusion that their teachers have not used them in the previous classes. They further said that teachers should expose them to experiments instead of explaining the processes in class and moving on to the next topic without allowing them to experience and see the real things; thus denying them the chance to develop important scientific skills. This assertion by students was true according to some teachers who agreed that they do this for the simple reason they are not sure how to demonstrate the process to the students. These results imply that some teachers lack what it takes to lead students to achieve satisfactorily hence the need for continuous training. Continuous update of teaching skills will help to eventually acquire deep knowledge of primary school content, expand their ability to handle examination classes and give more insights in handling experiments.

From the results of this study teachers desire continuous training to improve KCPE performance. To advance in their knowledge, dialogue and reflections with colleagues as well as peer observations could be used as effective ways as seen in this study. As seen in her paper, Colby (2000) suggests that professional development can help overcome shortcomings that may have been part of teachers' pre-service education and keep teachers abreast of new knowledge and practices in the field. This ongoing training for teachers can have a direct impact on student achievement

The assumption that college education fully instils the desired skills for teaching and that teachers will deliver desired content well has been questioned by the findings of this study. All the teachers asked for some kind of help to improve their practice of to refresh their skills pointing to a need for continuous professional development of staff. To focus attention on improving not only the quality of teachers and teaching materials.

5.3 Conclusion

From the findings of this study, and borrowing from reviewed literature in chapter 2, the contexts in which learning takes place must be supportive and comfortable and improving the psychosocial learning environment will lead to students effective learning (Wahyudi, 2004).

From the findings of this study, the following conclusions were drawn as being the ways of improving teaching and learning of science in line with the four research questions.

- a) Improving the learning conditions for students by providing textbooks, media, apparatus and materials for teaching will make the science laboratory a conducive place for science teaching and learning. These are the student materials and instructional media identified by both teachers and students as necessary for the science laboratory. These should be collected in a science laboratory that satisfies the requirements of a classroom such as space, lighting, ventilation, safety and order.
- b) When students manipulate the above mentioned materials, following the guidance of their teacher, they learn to engage and communicate openly with each other and with their teacher. As they do this, they collaborate well in their learning and understand the learning content easier. These are the relationships that should be cultivated in the science learning environment to enhance the social environment at the school in order to stimulate more student effort.
- c) Improving teacher preparedness for teaching. With the provision of a well-equipped science laboratory and a database for teaching notes and media with the syllabus requirements well spelt out, many teachers now feel better prepared to teach science. Novice teachers found it useful when learning targets were aligned to specific science equipment borrowing from the of the more experienced teachers.
- d) Providing ongoing training of teachers in service to instill desired skills for teaching and to improve their practice. Teacher experience and teacher education level have been viewed as two characteristics that are related to teacher quality in this research. Any effort of initiating improvement in a school setting should consider improving the capacity of teachers.

At the completion of this research, the science environment was found to be more learner friendly with an emphasis on working with teachers. Thus, teacher development as a critical factor in the paradigm shift being promoted (Sjøberg, 2001). As we worked to provide scientific resources, tools, and techniques for use by students, we modified the facility where the laboratory activities take place to make it more usable and student friendly.

5.4 Recommendations

The study recommends improved learning conditions for students; improved social environment in the school; improved teacher preparedness for teaching and professional development of teachers. The school should design structures that support the learning of teaching staff which is critical for student success. This study recommends that future teacher development program must provide these teachers with effective pedagogical and technological support to reduce the gap between their beliefs and their actual practices.

5.5 Challenges and limitations

Since this is a case study research, the results cannot be generalized to all the schools because the school investigated is unique in its constitution and ethos. The study however was useful in discovering the critical aspects in the contexts of a private school that need to be addressed to foster a holistic science learning environment.

This being a qualitative study and due to its changing nature, I had to constantly go back to refine the research problems as I guarded against drifting away from the original research problem. I found data gathering and analysis time consuming as I often had to explain the research over and over again to some participants whose main aim was to see transformations and were not so keen with giving information. This being my first research, I may not have had enough experience to obtain information and sometimes I missed some opportunities to gather data only to realize it a little later. This however was easier to correct as I was a participant researcher.

One aim of this study, the effect of the improvement of the science laboratory on the KCPE performance, was not studied for the reason that the duration of the study after improvement did not fall in the examination period. This has not affected the findings of the study and a further recommendation will be made in the next section.

5.6 Suggestions for further research

Other people interested in research in transforming schools may use this same approach to find ways to improve science learning environments in their schools. The research offers a contribution to existing theory on how to improve practice by offering explanations of possible processes needed to improve learning. Further research is suggested to investigate the effect of the laboratory

improvement on KCPE performance. In addition, the framework generated in chapter 4 needs to be tested in a larger number of schools to check whether it can be generalized (and to what extent).

This research was carried out with the full knowledge of all the teachers in the primary school. It has already impacted on the other panels. One of them (Social Studies) has already expressed interest to borrow our ideas to improve their panel. Further research can be carried out in this area to find out the requirements for this subject.

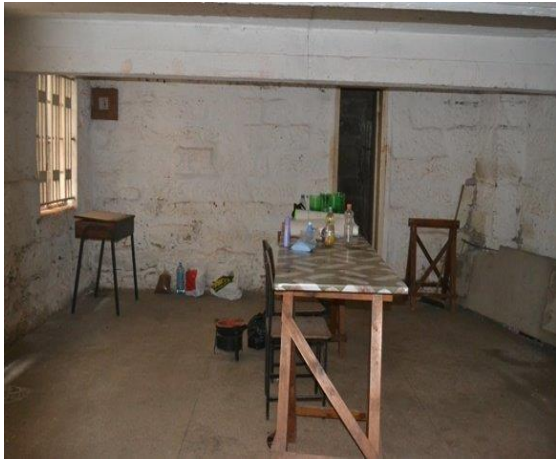
References

- (2007). Retrieved from Partnership for 21st Century Skills:
<http://www.21stcenturyskills.org/route21/>.
- Atkinson, R. D. (2007). Addressing the STEM challenge. 14-23.
- Banilower, E., Cohen, K., Pasley, J., & Weiss, I. (2010). *EFFECTIVE SCIENCE INSTRUCTION: What does research tell us?*
- Brotman, F. M. (2008). Girls and Science: A Review of Four Themes in the Science Education Literature. *JOURNAL OF RESEARCH IN SCIENCE TEACHING*, VOL. 45, NO. 9, PP. 971–1002.
- Cohen L. (2007). *Research Methods in Education*. London: Routledge.
- Colby, J. (2000). Defining Quality in Education. *A publication of UNICEF*.
- Cox, J. (n.d.). *Strategies to boost test scores*.
- Creswell, J. W. (2007). *Qualitative inquiry and research design: choosing among five approaches*. Sage Publications.
- Creswell, J. W. (2009). *Research Design: Qualitative , Quantitative and Mixed Approaches*. Sage Publishers.
- Demand and Supply of Primary and Secondary School Teachers in Australia. (2003).
- Doppelt, Y. C. (2008). Identifying students' perceptions of the important classroom features affecting learning aspects of a design-based learning environment. 195-209.
- Dumont, H. I. (2010). *The nature of learning: Using research to inspire practise*.
- Fadzil, H. M. (2014). Enhancing STEM Education during School Transition: Bridging the Gap in Science Manipulative Skills. *EURASIA Journal of Mathematics, Science & Technology Education*,, v10 n3 p209-218.
- Fadzil, H. M. (Dec 2014). Exploring the Influencing Factors in Students' Acquisition of Manipulative Skills during Transition from Primary to Secondary School. *Asia-Pacific Forum on Science Learning and Teaching*, v15 n2 Article 3.
- Files, A. (2005, October). <http://www.eldis.org/cf/rdr/rdr.cfm>. Retrieved from www.eldis.org/cf/rdr/rdr.cfm
- Given, L. M. (2008). *The SAGE Encyclopedia of qualitative research methods*.
- GOK. (2007). *Ministry of Planning and National Development, 2007: Kenya Vision 2030*.
- Handre, P. L. (2010). Engineering a Dynamic Science Learning Environment for K-12 teachers. *Teacher ducation Quarterly*, 1-21.
- Hine, G. S. (2013). The importance of action research in teacher education programs. *Issues in Educational Research*, 151-163.

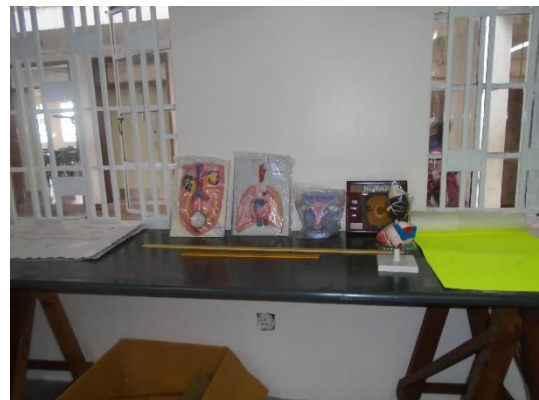
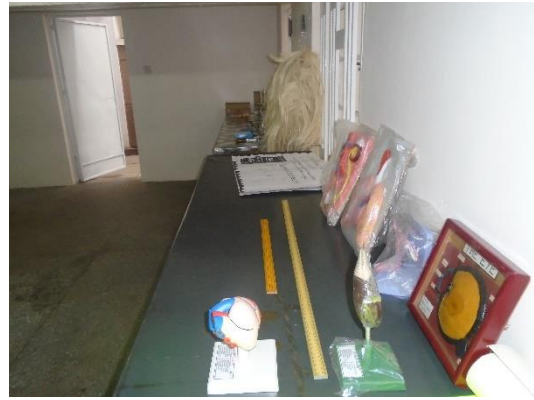
- Hofstein, V. L. (1982). The Role of the Laboratory in Science Teaching: Neglected Aspects of Research. *Review of Educational Research*.
- Hopland, A. O. (2016). Learning Environment and Student Effort. *International Journal of Educational Management*, v30 n2 p271-286.
- Hudson, P. (2015). *Hudson's guide for teaching primary science*. Australian eBook Publisher.
- Kapting'ei P, D. K. (August 2014). Challenges facing Laboratory practical approach in Physics Instruction. *International Journal of advancement in Research and Technology*.
- Kothari, C. (2004). *Research Methodology, Methods and Techniques*. New Delhi: New Age International publishers.
- Kwok, P. W. (2015). Science Laboratory learning environments in junior Secondary Schools in Hong Kong. *Asia-Pacific Forum on Science Learning and Teaching*, Vol 16, Article 9.
- Lombardozi, C. (2015). Learning environment by design.
- Mack, L. (October 2010). The Philosophical Underpinnings of Educational Research . *Polyglossia* , Volume 19 pg 5-11.
- Mills, A. J. (2010). *Encyclopedia of case study research*. California: Sage Publications.
- MOEST. (2015). *NATIONAL CURRICULUM POLICY*.
- Osborne, S. S. (2003). Attitudes towards science: A review of the literature and its implications, *International Journal of Science Education*,. 25:9, 1049-1079.
- Quinell, S. (2016, May 25th). Retrieved from <http://www.sec-ed.co.uk/site/>.
- Sharon P, K. K. (2010). 21st Century knowledge and skills in educator preparation.
- Sjoberg, S. (2001). Current Challenges and Possible Solutions. *Science and Technology in Education*.
- Sjøberg, S. (2001). Science and Technology in Education – Current Challenges and Possible Solutions.
- Vaccarino, F. M. (2007). Action Research Reflections: The wAngAnui Adult liteRAcy And employment pRoject.
- Wahyudi, D. F. (2004). Learning Environments and Students outcomes in Science in Indonesian Lower Secondary Schools. *Journal Of Science and Mathematics in SE Asia*, VOL 27, No 1, 139-165.
- Yin, R. K. (1994). *Case Study Research Design and Methods* . India: Sage Publishers.

Appendices

A. The science lab before the intervention



B. The science lab after the intervention



C. Students' reflections before intervention

STRUCTURE
Well, the wall could use new paint and you need to get rid of the cracks. The room needs cleaning.

TEACHING
First of all, there needs to be more space. Otherwise, it's OK. One thing you should add is a blackboard.

LEARNING
Well, long and tall tables with lab seats would be awesome. There should also be a sink somewhere to wash up after experiments.

STORAGE
Cabinets and shelves on one side of the room would be helpful to store books and lab supplies.

PS: There should be racks for lab coats and a drawer for safety goggles. The room needs more windows.

I hope this was helpful. I'm looking forward to seeing the newly-refurbished lab.

Structure
⇒ At this point the room isn't very appealing. It would need some cleaning and dusting and the door looks like it's about to fall.

Teaching
⇒ It's easy to teach there because it is very near the classrooms.

Learning
⇒ It ~~would~~ would be nice to have thin, long tables and lab chairs for the students to sit or stand depending on the situation.

Storage
⇒ There is absolutely nowhere to store anything right now. What would be needed is maybe some cupboards, shelves, some plastic boxes and hooks maybe.

D. Teachers' reflections before intervention

The current science lab is not functional as the space is very limited and the ventilation is very poor.
 My ideal science lab should be spacious, well ventilated, have enough working tables, lab stools and cupboards.
 A projector and screen would also play a great role in ensuring viewing of video clips during learning.
 This would motivate teachers to engage in more practical lessons and the pupils will learn better as they would manipulate the teaching aids.

State of the lab:

1. Not ventilated
2. Too tiny
3. No large tables
4. Poor lighting
- 5.

How it should be:
 Very spacious, well ventilated, with large tables and lab stools and shelves, also a bunsen burner.

It will help in making science more practical.

SCIENCE ROOM

- 1) Well ventilated
- 2) Spacious to fit a whole school
- 3) Lab tables and lab stools
- 4) Shelves
- 5) Well equipped.

- Such a science lab will help in:-

- a) carrying out experiments
- b) proper and fast coverage of syllabus
- c) pupils will be hands on and well exposed.
- d) easy to refer previous classes work.

Science Lab.

- It is small for a class.
- Stuffy and poorly ventilated.
- No space for displays.
- The room is dark.
- + Tables are few.

Should be:

- Spacious for a whole class.
- Have high walls for displays.
- Well ventilated in case chemicals are used.
- Should be equipped with basic equipments like test tubes & burners.
- Should have taps to provide water readily.

For now it's not well ventilated and it's not spacious.

- We need to get another room from the main building which is big.
- Divide the parts according to topics (in primary)
- shelves should be in different colours.
- We should also have a lab attendant.
- Written rules should be displayed outside the door.

The State of the lab

- It should be very spacious.
- It should have tables.
- It should be well ventilated.
- It should have lab stools.

It will benefit students to carry out alot of science practicals in it but not in class.

- Spacious and well ventilated.
- Large tables and LAB stools for the learners.
- Shelves
- Bunsen burners and test tubes.
- Lab attendant.
- Lab coats / Dust coats / Gloves and Safety boots.

E. Journal

Science panel meetings

Agenda: Science Room project

The aim is to develop curriculum/ instruction material for the existing Science room with the help and support of the science teachers. To do the following;

- a) Make a collection of
 - i. Teaching Aids for upper primary Std 4-8
 - ii. Charts
 - iii. Models
 - iv. Apparatus for experiments
 - v. Teaching video clips, pictures, students at work saved on hard disk
 - vi. Soft copy of schemes of work and broad schemes
 - vii. Soft copy of lesson notes

- b) Improve the state of the room so that the items can be stored well and teachers can prepare for experiment comfortably. I desire to increase these to three long tables and some shelves onto which the above materials will be placed. Some nails/hooks for hanging charts will also be put in place. The door that opens to the outside will be put in place and the windows will be improved to *roofers* that can be opened without causing harm to those passing outside the room.

- c) Develop rules for the use of the room and the items.

- d) In service training for the teachers since their teaching methods will be reinforced during the research period. All the teachers will learn various ways of looking for education materials thus improving their scholarship. Together with that, participation increases motivation and helps to concretize the whole syllabus for all including those that never have a chance to reach the higher classes. The topics were shared in the science panel

Schemes of work were written as allocated by panel head

5th September 2016

Dear Science Panel Member,

Please use the table to structure your work. You can use the copy given as a checklist. I will use it when collecting what you have done and when compiling the whole work.

Topic: e.g. Health Education

Class	Subtopic	Objectives	Notes	Teaching Aids/ Resources Available	Suggested Demos	Suggested students activities	What to be sourced during teaching	Apparatus for experiments	Suggested homework
1									
2									

Please let me know your problems, in writing preferably.

Thank you very much—J. Murage

12th September,

Kindly take note of the following dates in relation to the science room project.

Proposed date to give in commercial materials to be purchased **19th September 2016**

Proposed date of purchase of the items **29th September 2016**

Thank you very much for all you are doing

Juliana

The above plan was shared and several queries arose related to the subtopics suggested. They were explained sufficiently by myself and those teachers who seemed to have

understood clearly, specifically Mrs. P. Ng'ang'a. The teachers felt assisted since the requirements have been narrowed down.

All topics are taken care of. One teacher left and another is on maternity leave. We redistributed the topics. I as researcher took one.

19th September,

Dear Teachers,

I would like to have a meeting with you today at tea time 9.50am. Please remember to carry the list of commercial materials needed for your topic.

- Agenda:
1. Project update- today, 29th
 2. Post mortem- Science seminar
 3. Proposed date to hand in complete work

-The teachers' major problem is still typing of notes and other requirements. They asked for the deadline to be pushed some more to Thursday 22nd for list of materials and 24th October for complete work which was. Challenge i. Failure to beat deadlines ii. Participants do not yet realize the benefit of the project; they are not self-driven. I duly informed the teachers that no matter how far the deadline is pushed they will still not have that sufficient time they think they will have with the increased days. What is required is for them to focus on the task, to devote extra time to the activity and set own targets and deadlines in order to finish and get it done. I will collect the lists from each of them personally as I seek to understand the personal difficulties each of them is experiencing.

- I will compile one list from what all of them will give and organize for money and the day to purchase the items. Not all teachers can go on the buying trip.
- The science seminar with students and teachers was facilitated by Mr. Mayaka. Students felt it was the single most important activity they have had in science this year. He gave an overview of all skills needed in different topics in the science syllabus, reasons why pupils fail in KCPE and demonstrated what teachers need during the teaching process.

22nd September

I sought feedback from the pupils (open forum) that participated in the above seminar. They pointed out the following important

Teachers to do experiments in class. They should not just explain the experiments.

1. A summary of each topic should be done after teaching the topic.
2. To make charts that will make the topics easier to understand.
3. Teachers to bring realia to class e.g. weeds

4. Take pupils outside for practical learning.
5. Go through frequently failed KCPE questions.
6. Make the classes more interesting.

26th October 2016

Re: Science seminar

To: All science panel members

We shall have a science panel seminar today at 1.30pm in steers. You will notice that the exam timetable has been done to facilitate this. Kindly be punctual

The seminar relates to the science room project but a few other issues will be discussed.

Please carry the text books you used to prepare your work and a copy the syllabus. If you have not given me your work kindly put in a flash disk to hand it in during the meeting.

If you are reading with Std 1-3, you ought to have finished by 12 noon.

The agenda is as follows;

Assessment of desired materials per teacher per class

Input by other members-add, take away

Presentation-health education showing expectations

Feedback-challenges experienced

Way forward

Thank you

J. Murage

6th February 2017

RE: science room charts

Teachers to draw relevant charts topic wise.

Purchase a few charts for Std 1-3

1st March

Purchase of more commercial materials

F. Students' questionnaire

Name:

Class:

Date:

Title of research: Investigating ways to improve the science learning environment to foster teaching and learning in the primary section of Borough School.
Organizes lessons that require the use of science equipment

Student materials and media

Discuss your science lesson in relation to i. Use of science equipment ii. Opportunities for independent hands on science. iii. Allows experiments and discovery of concepts for myself

Student relationships

Explain science activities and group work with my peers during and after the lesson

Learning goals

Does the teacher explain goals or purpose for each class?

Does she provide practical opportunities to achieve the goal? Explain briefly.

Teacher knowledge and skills

How would you like your teacher to present her lesson to enhance your understanding?

Comment on the new facility using your own words using the following headings:

Structure of the room and availability of science materials and apparatus.

The effect it has on teaching and learning.

Storage space and orderliness of the place.

H. Teacher questionnaire

Name:

Current teaching class:

Date:

Level of qualification: Please tick as appropriate

Teaching degree----- i. Complete----- ii. Ongoing----- Other-----P1 certificate -----

Any other qualification (name) -----Any extra training received during your teaching

career-----**Highest level taught** (science only) Std 7-8--- Std 5-6--- Std 3-4--- Std 1-2---

Title of research:

Investigating ways to improve the science learning environment to foster teaching and learning in the primary section of Borough School.

Please answer the questions below using your own words.

Student materials and media

- i. What is the difference between the current science room and the previous one?

Student relationships

- ii. How would you describe the interactions of students as they work with materials in the new lab?
- iii. What about the interactions between teachers and students; and teachers and other teachers?

Learning goals

- iv. How do you conduct your lesson since the structuring of the new lab? What is the difference between now and before the transformations?
- v. Do you know of any equipment that you will need, while teaching, to achieve education goals that is not available? Explain your response.

Teacher knowledge and skills

- vi. What challenges do you face when teaching science in the school? (In relation to knowledge and skills for teaching science)

- vii. Comment on any of the challenges that have not been addressed by this research.
- viii. How can the school help you to improve on these challenges?

I. Teacher interview guide

Brief description of the project:

Investigating ways to improve the science learning environment to foster teaching and learning in the primary section of Borough School.

Interviewer:

Interviewee:

Time of interview:

Materials and media

- i. What changes have you witnessed since this research begun? Relating to physical facility, materials, order of the room. *Probe.*

Student relationships

- ii. What, in your opinion, has been the impact of this research to science learning in students?
- iii. How has the availability of the materials helped pupils to relate to each other? How would you rate their level of involvement? Worse, better, the same?

Learning goals

- iv. How will the available equipment help you to achieve education goals?
- v. Which other documents have been made available with the physical materials in the lab?

Teacher knowledge and skills

- vi. How were you involved in this research?
- vii. How has this research improved your teaching skills and knowledge in science?
- viii. What in your opinion is the best type of training needed to deliver science effectively?

J. Teacher Informed consent form

From: Juliana Murage (researcher)

Borough School

Research title: Investigating ways to improve the science learning environment to foster teaching and learning in the primary section of Borough School.

Guarantee of confidentiality to the participant

I guarantee that I will not disclose directly any information provided in this group to third parties, unless permission has been granted to do so. As some of the comments made in this group may be of a personal or private nature, participants should respect the confidentiality of individuals and also not disclose information directly to third parties.

You are a free participant and you can withdraw at any time if necessary.

Anonymity

I guarantee that I will not use any names and addresses in the final report, or store or categorize information using names and addresses. This will help to ensure that what you have said during the discussions will not be traced back to you by third parties.

Right to comment

I agree to keep you informed about the progress of the research. If at any stage you wish to comment on the emerging results or final report you may do so. I agree to listen to your comments and make relevant alterations, if appropriate.

The final report

This research is funded by Borough School. A copy of the final report will be sent to them, to the University library and to anyone who has taken part in the research who has requested a copy.

Teachers consent form

Name	Title/ Designation	Date
------	--------------------	------

I hereby consent to give information for this study:

An investigation into ways of improving the Science Learning Environment in Borough School, and understand that the data collected will be used to improve the current situation in the school.

Signature

K. Student Informed consent form

From: Juliana Murage (researcher)

Borough School

Research title: Investigating ways to improve the science learning environment to foster teaching and learning in the primary section of Borough School.

Guarantee of confidentiality to the participant

I guarantee that I will not disclose directly any information provided in this group to third parties, unless permission has been granted to do so. As some of the comments made in this group may be of a personal or private nature, participants should respect the confidentiality of individuals and also not disclose information directly to third parties.

You are a free participant and you can withdraw at any time if necessary.

Anonymity

I guarantee that I will not use any names and addresses in the final report, or store or categorize information using names and addresses. This will help to ensure that what you have said during the discussions will not be traced back to you by third parties.

Right to comment

I agree to keep you informed about the progress of the research. If at any stage you wish to comment on the emerging results or final report you may do so. I agree to listen to your comments and make relevant alterations, if appropriate.

The final report

This research is funded by Borough School. A copy of the final report will be sent to them, to the University library and to anyone who has taken part in the research who has requested a copy.

Parent's consent form

Name

Student's name

Date

I hereby consent my daughter to give information for this study:

An investigation into ways of improving the Science Learning Environment in Borough School, and understand that the data collected will be used to improve the current situation in the school.

Signature



Strathmore
UNIVERSITY

13th February 2017

To whom it may concern

RE: REQUEST TO CONDUCT RESEARCH

This is to certify that Juliana Murage (Admission N^o: 089040) is a Master of Science in Education Management student at Strathmore University. To complete her Master's degree, she is required to write a dissertation applying the knowledge and skills she has acquired.

Her dissertation is entitled, "**Investigating ways to improve the science learning environment to foster teaching and learning in the primary section of Borough School**"

She is also required to collect data from the school and other respondents.

We shall appreciate any assistance given to her.

Yours sincerely,

Dr. Magdalene Dimba
Director of Research
School of Humanities and Social Sciences

Date: 5th February, 2016

To: Juliana Munge c/o SC PS

From: Academic Council c/o Lina

Re: Your Proposal for your Thesis Project in the Science Room

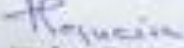
The AC agrees to your proposal for your Thesis Project of developing and enhancing the teaching aids for Science in Kianda Primary Section.

You will need to liaise with Miss Evelyn Khamati and Mrs Grace Waineri in regard to the Participatory input from the staff of the Primary Section.

As regards the upgrading of the Science Room, ref b) of your proposal, you will need to make your proposals to the Accounts Department to see how the Budget will accommodate with your needs.

We are very happy and appreciate your contribution in uplifting the material and teaching standards of the School.

We wish you all the best in this project.



Lina Sequeira

Acting Principal

C.C. Mrs Khamati, Chus Muroi