TEACHERS' CONCEPTIONS AND CHALLENGES OF LESOTHO GENERAL CERTIFICATE OF SECONDARY EDUCATION (LGCSE) EXTENDED MATHEMATICS CURRICULUM: A CASE OF TWO TEACHERS IN LERIBE HIGH SCHOOLS

By

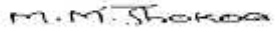
'Makholu Maureen Thokoa (200602008)

A dissertation submitted in fulfilment of the requirements for the degree of Masters of
Science Education in the Faculty of Education at the National University of Lesotho

SUPERVISOR: DR NOMUSIC MOROBE

DECLARATION

I, hereby declare that this dissertation titled, **TEACHERS' CONCEPTIONS AND CHALLENGES OF LESOTHO GENERAL CERTIFICATE OF SECONDARY EDUCATION (LGCSE) EXTENDED MATHEMATICS CURRICULUM: A CASE OF TWO TEACHERS IN HIGH SCHOOLS,** is my own work. All sources that have been used in dissertation is indicated and acknowledged by means of complete references. This dissertation has not been submitted previously in part or whole for examination for a degree at any institution.

Signed:  DATE**:** June 2022

MAKHOLU MAUREEN THOKOA

Statement by supervisor:

This dissertation is submitted with the supervisor's approval.

Signed_____ DATE: _____

Supervisor: Dr. Nomusic Morobe

DEDICATION

To my son: Katleho Lawrence Thokoa

My mentor: ‘Manaleli Edith Sebatane

My sisters: Nts’ebo, Nkepile and Seipati

All the sons and daughters of Thokoa family

My friends: Metsing Joseph Metsing and Lisema Alexis Nts’asa

Your unconditional support, patience and motivation kept me going. You empowered me to make my dream come true. You believed in me and encouraged me to pursue this challenging, exciting, fruitful journey.

ACKNOWLEDGEMENTS

- I would like to thank Almighty God for providing me with strength and wisdom during this study.
- My deepest gratitude goes to my supervisor, Dr. Nomusic Morobe for her supervision, support, guidance and professionalism; without you, Doctor, I would have not successfully completed my dissertation, thank you again. Your passion for research in mathematics education has been an encouragement to me.
- I am also grateful to my son, Katleho L. Thokoa for being so supportive and caring during my study.
- My deepest gratitude also goes to teachers who participated and were willing to spend their own precious time in my research.
- I also would like to thank my colleagues for their advice. They helped in diverse ways to make my thesis a successful one.

ABSTRACT

The purpose of this study was to investigate teachers' conceptions and challenges of the Lesotho General Certificate of Secondary Education (LGCSE) Extended Mathematics Curriculum. The sample size of the study was two mathematics teachers from different schools. Teachers were purposively sampled while schools were purposively and conveniently sampled. Questionnaire (open-ended questionnaire), observation and interview (structured interview) were used to collect data, in order to gain as thorough understanding as possible of the case and its context.

The interview and observation data were transcribed and the questionnaire, observation and interview data were analysed separately by organising the data, selecting ideas and concepts and organising them into categories and similar categories were sorted under one overarching theme. The schools were named schools A and B, and teachers were given pseudonyms (Miss Mafa and Mr. Thaba). The findings were presented in a narrative format that would be rich in detail and description.

The study revealed that teachers do have conceptions/understandings concerning LGCSE Extended Mathematics Curriculum. Teachers' reasoning contradicts with what they practice in their classrooms. Again, teachers do encounter challenges when implementing Extended Mathematics Curriculum such as workload, lack of skills to enact Extended Mathematics Curriculum, lack of content knowledge, lack of teaching materials (textbooks), lack of clarity about Extended Mathematics Curriculum and resistance to change when implementing Extended Mathematics Curriculum, especially at schools where there is only one mathematics teacher.

KEYWORDS

Core

Extended

Conceptions

Challenges

Concerns-Based Adoption Model

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AMS	American Mathematical Society
CAPS	Curriculum and Assessment Policy Statements
CBAM	Concerns-Based Adoption Model
COSC	Cambridge Overseas Secondary Certificate
GCE	General Certificate of Education
IGCSE	International General Certificate of Secondary Education
JC	Junior Certificate
LGCSE	Lesotho General Certificate of Secondary Education
LoU	Levels of Use
MOET	Ministry of Education and Training
NBCSTs'	National Board Certified Science Teachers
OBE	Outcomes-Based Education
RNCS	Revised National Curriculum Statement
SBST	School-Based Support Teams
SI	Standard International
SMSG	School Mathematics Study Group
SMT	School Management Team
SoC	Stages of Concern
UK	United Kingdom
USA	United States of America
NCDC	National Curriculum Development Centre

CHAPTER ONE

INTRODUCTION AND OVERVIEW

1.1 Introduction

This chapter provided the background of the study by giving a brief account of the changes in mathematics education across the world and in Lesotho. It also provided the background of the Lesotho General Certificate of Secondary Education (LGCSE) Mathematics curriculum and the need for learning LGCSE Extended Mathematics. Furthermore, it discussed the statement of the problem, purpose of the study, research questions and significance of the study.

1.2 Background of the study

Basotho practiced traditional education from the 1820s and included informal and formal ways of transferring knowledge and skills to their children (Letsie, 2019). It was viewed in a global perspective, not as a set of specialisations, and understood as a collective responsibility. In the past, there were informal learning institutions where boys and girls learnt cultural values, personal and family responsibility, and duties for one's clan independently (Muzvidziwa & Seotsanyana, 2002). The researcher opines that in the traditional context, education gave a child a sense of protection, belonging, identity, and success. Pre-colonial contributed considerably towards the cultural and personality maturity of individual. This study focuses on the changes in mathematics education across the world and in Lesotho from late 1950s to the end of the first decade of the 21st century when the new LGCSE Extended Mathematics Curriculum was developed, disseminated and implemented.

Lesotho has been faced with changes in mathematics education. These changes impacted on the curriculum in the country. As a result of Russia's space exploitation (Mills, 1969), and the launch of the Sputnik in the late 1950s (Ambrose, 1969), and its worrying ill-effects in the Eastern world (Mills, 1969), led to the analysis of content and teaching methods in education. This forced the Americans to focus more on Mathematics and Science curricula and set up many mathematics curriculum groups to develop a new curriculum for high schools (Furinghetti et al., 2013). Ambrose (1966) states that there had been numerous calls for mathematics teaching reform, although this was the first time that the required resources had been made available. The American Mathematical Society (AMS) came up with different curriculum projects to improve

the quality of mathematics and science education. Among the groups established in the United States of America (USA), School Mathematics Study Group (SMSG) was the most powerful project to improve the new curriculum for high schools (Furinghetti et al., 2013). After carrying out mathematics curricula content in numerous countries, the core agreement was made regarding significance of algebra in schools. Here, numbers and variable were substituted by letters, followed by algebra formulae then solutions to linear equation and quadratic, with simultaneous linear equations, and the properties of the roots of quadratic and cubic equations inclusive. Therefore, algebra was introduced as part of the curriculum. Although in England, university lecturers worked on the curriculum, and did not encompass the same spotlight as high school teachers, as a result incorporated fields like Abstract Algebra.

The other changes in mathematics education occurred in early 1960s, in the United Kingdom (UK), the school mathematics projects commenced in 1961 (Furinghetti et al.,2013). The Entebbe project was also established as one of the most important projects. Some of the African countries became part of the Entebbe project like Uganda. In Uganda, the Entebbe Project based in Entebbe was one of the projects that came up with the textbooks with the African environment as part of reform movement. The aim of Entebbe texts was to present new mathematics in the behaviour appropriate to the environment and educational systems of Africa countries (Ambrose, 1966). He further clarified that it was then decided to hold a workshop at Entebbe in Uganda to start preparing texts on the new mathematics. After the workshops the drafts texts were printed and completed for use in the following school year. According to Ambrose (1967), the majority of the participants and writers were American expatriates and treatment of many topics was along the lines parallel to those of North American curriculum reform movements. Dlamini, (1968) states that the Entebbe Mathematics series were introduced to training colleges and teachers were presented refresher courses to value the modern mathematics ideas. The difficulties in the recruitment of mathematics teachers and agitation among university mathematicians about the type of mathematics being taught in schools, reached a point where something has to be done (Ambrose, 1966). Therefore, the British reform movements known as the School Mathematics Project (SMP) developed books known as SMP (1, 2, 3 …). These books were appropriate for any high school looking forward to making the first move on modern mathematics after the Junior Certificate (JC) syllabus and examination

(Ambrose, (1967). The researcher also believes that the Standard International (SI) units of measurement were also a move to the use of a metric system.

According to Furinghetti et al. (2013), the 1970s were fruitful years for the establishment of projects. Several changes came up in mathematics education and after long debates and majority of schools favoured SMP books. The reason being that colonial countries used the same books in their teaching and learning programme. Botswana, Lesotho and Swaziland started on the alternative new mathematics because of the easier language and less abstract approach (Ambrose, 1970). On the other hand, Ambrose further indicated that a more serious objection which applies to SMP books was that many examples were taken from British environment even though the books have a new and unique approach to numerous sections of the syllabuses. Therefore, the three countries adapted SMP A-B-C-D-E. These books were interchangeable with Book 1 but their blend has a bias towards practical work from the introduction (Ambrose, 1969). The researcher is of the opinion that Botswana, Lesotho and Swaziland came up with which was called SMP BOLESWA which was more suitable for Lesotho and assembled with syllabus of that time. The workcards project was also one of the new projects introduced in mid 70s. In Britain workcards were on trial and Botswana, Lesotho and Swaziland were the first African countries to use workcards (Selwyn, 1974). Selwyn further indicated that workcards allowed learners to work on their own. However, many of the cards had poor explanations and they were in a complex language for learners understanding. The teaching approaches also changed and Americans worked on introducing discovery approach. They were also unaffordable for schools in Lesotho. The project was therefore unsuccessful from its initial pilot stage.

In the 80s and early 90s teachers and learners did not embrace the discovery method enthusiastically due to lack of training. Furthermore, learners and parents felt cheated since there was no teachers' performance in the schools. During this period, the Project in Secondary Mathematics (PRISM) Books 1-5 was developed. Their language was user-friendly and examples were provided from everyday life. More workshops were held for teachers' training in both content and pedagogy depending on the curriculum change. Botswana departed from JC examinations which was a joint venture of the BOLESWA countries in the early 90s, (Raselimo & Mahao, 2015) as a reaction to global patterns of educational change. Lesotho and Swaziland continued with the joint venture and came up with new PRISM books in the late 90s. The examples in the book were divided into Core and Extended and involved more problem solving.

However, the major issue in purchasing these books was the cost factor. These books were too expensive and that became an issue in the country. According to Raselimo and Mahao (2015), the new curriculum and assessment policy had been developed and presented; this encouraged both countries, Lesotho and Swaziland to develop PRISM 2000 mathematics textbooks.

More work was done on examinations in order to localise Cambridge Overseas School Certificate (COSC). The marking of examination scripts was localised after the training of markers but Cambridge University was still in control (Raselimo, 2010). As a response to the localisation reform, alternative syllabuses in subjects such as science and mathematics were produced in the early 1980s and put on trial in some schools in the mid-1980s (Raselimo & Mahao, 2015). According to Raselimo and Thamae (2018), in 2009, the Lesotho government through the Ministry of Education and Training (MOET) distributed a comprehensive curriculum and assessment policy framework. Furthermore, the new Lesotho General Certificate of Secondary Education syllabi were developed for secondary school subjects as part of the localisation arrangement. After much challenges and efforts Lesotho undertook to process localisation of its syllabi.

In 2013, Lesotho phased out COSC, and progressively introduced the Lesotho General Certificate of Secondary Education (LGCSE) Curriculum (Letsie, 2019, p.3), which is an adaptation of the International General Certificate of Secondary Education (IGCSE). This did not just bring only localisation of content but a notion to separate learners in mathematics in terms of their abilities. Therefore, the inception of the Core and Extended Mathematics Curriculum (LGCSE Mathematics Curriculum) is the Differentiated/Tiered Curriculum. Mathematics Core curriculum embraces basic content while Extended Mathematics Curriculum focuses on in depth content. The Extended curriculum is an advantage to learners who want to pursue mathematically related careers.

The modern reform in mathematics education introduced a change from teacher-dominated teaching approaches to learner-centred approaches, hence implying new roles for teachers and learners (Raselimo & Mahao, 2015). The new syllabus placed more emphasis on problem-solving and applications; thus encouraging critical thinking and self-reflection.

The LGCSE mathematics curriculum was examined for the first time in 2014 (Letsie, 2019). In this curriculum learners get a feel of numbers and can talk about the subject in a variety of ways. They also develop skills to apply mathematics in other subjects, particularly science and

technology. The mathematics syllabus has more international acceptance and is recognised by leading universities and employers worldwide, since LGCSE curriculum is an internationally recognised qualification (Letsie, 2019). "It lays a firm base for pre-tertiary qualifications as well as prepares candidates for world-wide employment should they decide to do so" (Mathematics (0178) Syllabus, 2016, p.2).

The new curriculum is learner-centred, which actively plans to implement the curriculum in a stepwise and level referenced manner, emphasising learner's voluntary and positive learning activity, and provides problem solving skills rather than rote learning skills. Therefore, teachers should provide learners with creative ways to develop and consolidate new knowledge. Besides having these good aspects, it is a differentiated curriculum.

The LGCSE mathematics curriculum is a differentiated type of curriculum which aims at meeting the different abilities or needs of learners in the classroom. The differentiated curriculum in Lesotho is organised into Core and Extended curriculum which has to be treated nearly simultaneously to learners of varied abilities and intentions in a period of two years from grade 11 to 12. On completion of Grade 12, learners are given an opportunity to tertiary education if they meet the requirements. The curriculum offered is balanced and provides flexibility in studies.

Learners have a choice of Core or Extended syllabus depending on their abilities and interests. The **Core** is the basic content and is meant for candidates who do not want to pursue mathematics careers but who can apply mathematics in everyday situations. The **Extended** is the in-depth content and is meant for candidates who want to pursue mathematically related careers and those who have an inclination for mathematics (Mathematics (0178) Syllabus, 2016). One difference between Core and Extended curriculum is grading. LGCSE mathematics curriculum recognises ability of range of learners and has eight-point grading scale, from A* to G. A learner for Core mathematics can achieve a maximum of grade C from options C, D, E, F and G. Grade C is the only grade recognised as credit. While Extended curriculum offers the following

Grades; A*, A, B, C, D, E, F and G with A* being the highest. However, learners who fail to attain the minimum satisfactory standard for either Core curriculum (Grade C) or Extended curriculum (Grade E) will be ungraded. The table 1.1 illustrates the differences in detail.

Differences	Core Mathematics	Extended Mathematics
Level of difficulty	Provides overview of the subject and covers basics of the topics	Provides in depth knowledge of the topics. it is a sort of specialisation
Available grades	C,D,E,F and G	A*, A, B, C, D, E, F, and G
Accepted for higher education in Mathematics	No	Yes
Coping with Mathematics at University level	May find it difficult	Naturally leads to higher education
Assessment	Learners need to write two exams: paper 1 & 3	Learners need to write two exams: paper 2 & 4

Table 1.2 represents the differences between Core and Extended Mathematics (Adapted from Shrabanti, 2017)

The new assessment model has four papers; paper 1 and 3 are for the Core curriculum – for those learners who opted for this curriculum. They will write papers 1 and 3. For the Extended curriculum learners will write papers 2 and 4. Papers 1 and 2 enclose short questions and candidates are required to answer all questions. The weighting of paper 1 and 2 is 35% with different marks. The Core examination paper is out of 60 while Extended is out of 70. Paper 3 and 4 are structured questions. Candidates answer all quest ions, and the papers weighting is 65%. The total marks for Core is 100 while Extended is 130.

LGCSE mathematics curriculum lays down a firm foundation for pre-tertiary qualifications (Mathematics (0178) Syllabus, 2016), and envisions changes in the assessment of Lesotho education which exposed that LGCSE is more relevant to the needs of Basotho than COSC (Letsie, 2019). LGCSE is reported to be internationally recognised (Raselimo & Thamae, 2018). COSC is based on a group award system but LGCSE exist as a qualification where performance in each subject is individually recognised.

COSC grades were A1, A2, B2, B3, C5, C6, D7, E8 and U9 while LGCSE grades are A*, A, B C, D, E, F, G and U. COSC was a group examination and had 1st class, 2nd class, 3rd class,

General Certificate of Education (GCE) and fail whereas LGCSE is a non-group examination and all subjects in the curriculum have same status hence English stopped to be a passing or failing subject. The syllabi for both COSC and LGCSE Mathematics require the learners to increase intellectual curiosity (Letsie, 2019, p.61). “The major difference between the two syllabi is that LGCSE Mathematics, unlike COSC Mathematics, differentiates between learners in terms of ability” (Letsie, 2019, p.62). The Extended Mathematics Curriculum focuses more on applications of mathematics concepts by involving learners in problem solving tasks. Letsie further clarified that COSC Mathematics syllabus required all learners to study the same content irrespective of their abilities.

The new mathematics curriculum success depends on teachers’ profession and teaching methods. Teachers are the ones who can make this curriculum more relevant. Relevance in terms of national development needs, particularly making the curriculum more contextually relevant is expected from all teachers (Raselimo & Mahao, 2015). LGCSE Extended Mathematics was examined in 2015. The number of learners who registered for Core and Extended Mathematics were equal but the following year the number of learners who registered for the Extended Mathematics Curriculum decreased. The decrease in numbers can be associated with several factors such as learners’ performance, learners’ attitude, teachers’ conceptions and challenges.

In this study, the researcher focused on teachers’ conceptions and challenges as a possible factor that could cause a decrease in numbers in Extended Mathematics. It is important that teachers implement Extended Mathematics Curriculum as the policy expected. Otherwise, the new curriculum will turn out to be a fruitless innovation.

1.3 Statement of the problem

Lesotho General Certificate of Secondary Education (LGCSE) mathematics curriculum is organised into Core and Extended. “Average learners only study the Core part of the syllabus, while learners with a high ability in mathematics study both the Core and Extended parts of the syllabus” (Letsie, 2019, p.62). The Core curriculum is meant for candidates who do not intend to pursue mathematically related careers, while Extended curriculum is suitable for those who have an inclination in mathematically related careers, as well as brighter candidates (Mathematics (0178) Syllabus, 2016). These two components are taught simultaneously in the classroom. In some schools there is only one mathematics teacher and he/she has to teach Core and Extended

in the same class at the same time. Due to the manner that the curriculum is put into practice in the classroom, teachers might have conceptions that may affect the teaching of Extended Mathematics Curriculum. Teachers may come across challenges in implementing Extended Mathematics Curriculum. According to LGCSE Mathematics examiners' report (2014), when the new mathematics curriculum was first examined, the number of learners who registered for Extended was 51%. In 2018 the number decreased to 42%, then in 2019 the number decreased to 33% and this shows that the numbers kept on decreasing. This requires an investigation into the possible causes for the decline in numbers registering for the Extended Mathematics option. It is of concern and wonder, if teachers understand what is required in the Extended Mathematics and whether they convey what is required in this section of the curriculum. Thus far, there are no studies conducted on teachers' conceptions of LGCSE Extended Mathematics Curriculum and teachers' challenges in implementing LGCSE Extended Mathematics Curriculum.

1.4 Purpose of the study

Since Core and Extended Mathematics had been introduced in schools, learners choose Core over Extended whereas Extended Mathematics is the one that offers better grades. The researcher was concerned that in the next five coming years there would be few numbers of Basotho children who would be able to carry out mathematics related careers like medicine and engineering. This study tried to make contributions through investigating possible factors namely: teachers' conceptions and challenges teachers face in the implementation of LGCSE Extended Mathematics Curriculum. That is why this study aimed to investigate teachers' conceptions/understandings and challenges of LGCSE Extended Mathematics Curriculum.

1.5 Research questions

- What are teachers' conceptions/understandings of LGCSE Extended Mathematics Curriculum?
- What are teachers' challenges in the implementation of LGCSE Extended Mathematics Curriculum?

1.6 Significance of the study

The findings of this study would benefit teachers since mathematics plays an important role in science and technologies. Teachers would also benefit by being able to apply learner-centred approach strategies as a result promotes learners' engagement in mathematics learning and be more involved in class activities and committed to their learning of Extended Mathematics. Also, learners might see mathematics in a positive way hence they can change their attitudes and values in Extended Mathematics, and gain understanding of their own learning style.

The findings of this research would also enlighten Extended Mathematics teachers about the conceptions and challenges of LGCSE Extended Mathematics Curriculum. Teachers would also benefit by improving on their interaction with learners and teaching and learning strategies in the Core and Extended classes for effectiveness in learner's performance. Based on the findings of the study, teachers can spot their weaknesses and strengths and as a result introduce strategies for improving teaching and they can get the proper support in implementing the new curriculum. Again, the study can guide the in-service programs by providing what is relevant for pre-service teachers to help them improve their professional development for effective teaching of LGCSE mathematics curriculum in Lesotho. Lastly the National Curriculum Development Centre (NCDC) which introduced the curriculum will be more informed of what is required in terms of teaching materials and training to make this new venture a success.

1.7 Conclusion

This chapter discussed the changes in mathematics education and differentiated curriculum in the form of Core and Extended. The Extended part, which is meant for learners who want to pursue mathematics related fields, seems to have declining numbers registering for it. In the absence of research in this area, the study would focus on conceptions and challenges in the implementation of the Extended curriculum. The chapter that follows provides literature that is relevant to this study and provides theory that guides the study.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter discussed the relevant literature on curriculum but in particular, differentiated curriculum that serves as a lens to this study. The concept and understanding of the differentiated mathematics curriculum in Lesotho was discussed in relation to the new curriculum. Teachers' conceptions and challenges related to mathematics, especially a new curriculum were also outlined. Concerns-Based Adoption Model (CBAM) will be discussed as a theoretical framework for this study.

2.2 Curriculum

Researchers had identified different definitions of curriculum. Du Toit and Gaotlhobogwe (2017), conducted a study that identified information that could be used to strengthen the curriculum of Botswana and South Africa. They defined curriculum as a depiction of standards, substance and forms to strengthen and it is as time depicted as what, why and when learners learn. The study by Young (2014) discussed the importance of curriculum theory and the current debate on school curriculum. He expressed curriculum as an educational concept and a form of specialised educational knowledge which mainly defines the kind of education people get. Young further explained that we can develop better and improve learning opportunities. On the other hand, according to Dezure et al., 2002 in Fung, (2017), the term curriculum,

> "includes goals for learners learning (skills, knowledge and attitudes); content (the subject matter in which learning experiences are embedded); sequence (the order in which concepts are presented); learners; instructional methods and activities; instructional resources (materials and settings); evaluation (methods used to assess learners learning as a result of these experiences); and adjustments to teaching and learning process, based on experience and evaluation" (p.18).

That is, curriculum is a blend of instructional practices, learning experiences, and learners' performance assessment that are designed to bring out and evaluate the target learning outcomes of a particular course. LGCSE Extended Mathematics Curriculum is also a detailed plan for instruction set by policymakers.

However, Khan and Law (2015), viewed curriculum as a basis of the teaching-learning process. Campbell-Phillips (2020) surveyed if education and curriculum reform can influence the way we learn, and how Campbell-Phillips viewed curriculum as a learning guide that is administered by a school board that is intended to address learners' educational needs, assist learners while finding relationships between teachers and learners. They further explained that curriculum is significant and brings order in the classroom and learners become more organised when engaging in their classroom work and related activities. Justine (2017) viewed curriculum in terms of forms structured in relation to positive aims, such as the explicit or overt, hidden and null curriculum. Justine further explained that explicit or overt refers to the official and intended body of learning which inherit the experience of running the course and includes a hidden curriculum that is contrary to the stated aims of the overt while null curriculum is obviously or significantly absent things that ought to have attention. As described in chapter one, LGCSE mathematics curriculum is divided into Core and Extended curriculum where Extended Mathematics Curriculum clearly contains basic content and in-depth content. According to the above definitions of curriculum, it becomes clear that curriculum is what happens in the classroom as well as inside the school and away from the school and all the activities teachers do to connect learners and all other relationships that make up the curriculum (Lesaoana, 2018).

2.2.1 Differentiated curriculum

According to Tomlinson and Imbeau (2010), differentiated curriculum can be accurately described as a classroom execution with an unbiased emphasis on individual learners and lessons content. Differentiated curriculum is a renewed way of teaching learners based on their strengths and weaknesses and should possess learners' interests to meet their needs, even though they are different from their classmates. Hlalele (2020) explored and documented School-based Support Teams (SBST) members, understanding and enhancement efforts concerning curriculum differentiation at a rural school where learners are regarded as underachievers, progresses and /or untrainable. Their study provided a variety of ways for learners with different abilities, knowledge and skills to access the curriculum so that they understand the value of the subject and to be in control of their own learning styles. Differentiation give learners the opportunity to be prepared for higher education by making sure that they learn the content, habits of mind, academic skills, and self-awareness essential for continuing learning (Tomlinson & Imbeau,

2010). Consequently, a differentiated curriculum expects mathematics teachers to consider that learners learn in different ways thus accommodating pace of progress or learning to meet each learner's unique processing speed. The same applies to LGCSE mathematics curriculum, hence, inception of problem solving in Extended Mathematics which learners enjoy and allows learners to use their own methods and make decisions about the way they explore mathematics problems. Furthermore, the policy expects teachers to recognise that learners use their prior knowledge; learners have options as to how they want to learn and how they demonstrate what they have learned. Hence, the majority of effective teachers in differentiated classrooms are more familiar with their learners and their teaching methods are flexible to accommodate their learners' abilities (Tomlinson, 2014). Tomlinson further explained that to accommodate learners' diverse needs, teachers agree to implement differentiated instruction.

2.2.2 Differentiated instruction

Robinson et al. (2014) investigated how teachers successfully differentiate instruction. They defined differentiated instruction as a means of teaching all learners and to assist them achieve a common goal. Similarly, a study by Robinson et al. assessed practices and challenges of differentiated curriculum. They viewed that the differentiated instruction involves knowing learners, understanding the curriculum, providing several pathways to learning, sharing accountability with learners and taking a flexible and reflective approach. These definitions embrace the significance of reaching every learner with respect to accommodate their various differences. For the purpose of this study, differentiated instruction involves understanding the LGCSE Extended Mathematics Curriculum, reaching out to every learner and introducing various teaching methods in order to meet their different interests and abilities.

Morgan (2014) studied a case involving a child having difficulty in learning and shows how differentiated instruction can be used to help learners learn. He revealed that teachers who are unconscious of learners' learning styles are likely to teach in a manner that prevents learners from doing their best work hence differentiated instruction can ease or reduce this disagreement. Morgan further, agreed that differentiated instruction requires a teacher to recognise that learners in his or her classroom differ from one another in their learning styles. Robison et al. (2014) discovered that differentiated instruction corresponding with constructivists learning theories recommends learners the opportunity to build upon their previous knowledge while developing

their own skills, interests, styles, and talents. This suggests that teachers should vary their teaching methods and present the information as the curriculum requires.

Tomlinson and Imbeau (2010); Nicolae (2013); Deringol and Davasligil (2020); Robison et al. (2014) indicated that learners participate actively in school if they are taught in an approachable way to their readiness, interest and learning profile. (Good, 2006 as cited in Melesse, 2015) referred this as learner-based differentiation instruction. Joseph et al. (2013) referred to this as key elements of differentiated instruction. Readiness refers to learners' knowledge, understanding, and skills related to a particular succession of learning (Deringol & Davasligil, 2020), may be influenced by factors such as previous experiences, approaches and mental behaviour. The Mathematic Extended curriculum repeatedly builds on information learned in previous years**.** Interest comes from topics that stimulate curiosity and passion in learners. Learners generally value the subject they are interested in more. Subjects that are new, exciting and interesting motivate learners intrinsically – thus, intrinsic motivation (Deringol & Davasligil, 2020). According to Joseph et al. (2013 p.29), 'when a teacher differentiates instruction according to learners' existing interests, these learners are motivated to connect what is being taught with things they value'. When learners see why they have to learn a topic, this enhances their motivation and retention. Therefore, differentiating instruction helps learners to understand themselves better, develop the insights and skills needed for personal and academic growth, and generate trust that is required to follow teachers (Tomlinson & Imbeau, 2010). Teachers can spark learner's enthusiasm and passion providing real-life examples, showing learners where they might use these experiences in the Extended Mathematics particularly in upper-level mathematics. Learning profile is all about how learners learn best, their learning styles, intelligence preferences, culture and sex (Deringol & Davasligil, 2020). Basically, learners often have different learning preferences although some learners prefer to interact with groups or the whole class; others feel more comfortable working alone (Joseph et al., 2013). Differentiation based on learning profile allows learners to learn in ways that are natural and efficient (Joseph et al. (2013). They further agreed that learners may be given the opportunity to work alone, with partners, or as a group. The teaching of Extended Mathematics provides itself a great deal of varied instructions.

According to Tomlinson (2014), teachers can differentiate four classroom elements (teacher-based differentiated instruction, (Good, 2006 in Melesse, 2015) based on learners'

readiness, interest, or learning profile: content, process, products and learning environment. On the contrary, Hlalele et al. (2020) viewed differentiation in terms of content, process and product. This study adopted how Hlalele et al. views differentiation in terms of content, process and product**.** Content refers to what learners need to learn; concepts, principles and skills that are taught and how learners will acquire access to the information. Visibly, differentiating content requires teachers to alter and adapt how they deliver mathematics skills to learners (Joseph et al., 2013). As outlined in chapter one, LGCSE Core mathematics curriculum, learners are expected to learn basic mathematical content and apply the acquired skills in their daily lives. In contrast, Extended Mathematics Curriculum expects learners to acquire in-depth content knowledge of mathematics and learners are able to apply the acquired knowledge and skills in more challenging mathematics problems and situations.

Although Process is concerned with the ways in which content is taught, that is activities in which the learners are engaged in order to make sense of or master the content (Tomlinson, 2014). Therefore, teachers should give learners activities that are congruent to their interests and abilities. The teaching methods should also be flexible to meet individual needs. Learners studying Extended Mathematics Curriculum can be grouped according to their level of readiness, interest and learning profile. Products allow learners to show whether they have learned the key concepts and skills of a unit and to apply learning to solve problems and take actions. Joseph et al. (2013) showed that product differentiation offers learners a range of pathways to show mastery of common learning goals. They further explained that for success, effective product differentiation assignments should offer learners clear and proper criteria; focus on real life application; promote creativity and ethical thinking; allow for varied methods of expression. 'It is a rich culminating assessment that calls on learners to apply and extend what they have learned over a period of time' (Tomlinson & Imbeau, 2010, p.15). In the Extended Mathematics Curriculum, learners are expected to express themselves more differently when assessed because they are more competent in mathematics. If teachers do not recognise that learners have different abilities according to the levels in the table below, this can lead to teachers' conceptions in Extended Mathematics Curriculum.

Examples of Differentiation Based on Learner Need			
	Readiness	Interest	Learning Profile
Content	• Material at varied readability levels • Alternate presentation methods • Targeted small group instruction • Highlighted texts	• Range of materials that apply Key ideas and skills to a variety of real-world situation • Teacher presentations designed to link to learner interest	• Varied teaching modes (e.g. verbal, visual, rhythmic, practical) • Video or audio notes for learners who learn better with repeated listening
Process	• Tiered activities • Mini-workshops • Flexible use of time • Varied homework assignments	• Expert groups • Interest centres • Supplementary materials based on learner interests • Jigsaw • Independent studies • Interest-based application options	• Choice of working conditions (e.g. alone or with a partner) • Tasks designed around intelligence preferences • Blogs to share ideas
Product	• Tiered products • Personal goal-setting • Varied resource options • check-in independence • providing samples of good learner work at varied levels of complexity	• use of learners in designing products • design a day options • use of contemporary technology for learner expression	• complex instruction • varied formats for expressing key content • varied working arrangements • varied modes of expressing learning

Table 2.2 shows particular examples of how the teacher can apply differentiation in the classroom. Adapted from Tomlinson and Imbeau, (2010, p.18).

Hlalele et al. (2020) used qualitative case study design and found that a differentiated but complementary understanding of differentiation resulted from differentiated enhancement endeavours. It is recommended that a concerted, collaborative and cohesive understanding of curriculum differentiation can be inculcated in all role-players in order to add value to teaching, learning and support. Joseph et al. (2013) examined the impact of using a differentiated instructional approach to teaching second year learners pursuing an undergraduate course in curriculum studies as a tertiary institution. Findings of their study revealed that learners at both campuses (tertiary institution) responded positively to the differentiated instructional approach, with 90% of participants reporting higher levels of intellectual growth and interest in the subject. Once more, assessment of learner learning revealed that the majority of learners in the differentiated classrooms demonstrated sound understanding of major concepts taught in the curriculum studies course. While 99% of learners expressed willingness to experiment with differentiated instruction in subsequent practicum sessions during their term at the university, and 88% indicated a desire to use a differentiated instructional approach in their classrooms upon graduation.

Butler and Van Lowe (2010) study focused on using differentiated instruction in mathematics education for pre-service teachers, including contextual information and particulars on differentiated unit on fractions and integers. Their study concluded that from the lesson itself there were few applied reflections for differentiating. On the other hand, Robinson et al. (2014) findings indicated that teachers perceive successful implementation of differentiated instruction as something that takes time to incorporate in the classroom, but rehearsal and persistence make it possible. Good, (2006) as cited in Butler and Van Lowe (2010, p.2), observed differentiated instruction as:

> "a way of thinking about teaching and learning that advocates beginning where individuals are rather than with a prescribed plan of action, which ignores learners' readiness, interest, and learning profile. It is a way of thinking that challenges how educators typically envision assessment, teaching, learning, classroom roles, use of time, and curriculum. It is a good teaching focused on key concepts and skills based on those concepts. All

learners, regardless of ability or readiness, should be challenged to make sense of these essential understandings".

Melesse (2015) assessed primary school teachers' perceptions, practises and challenges of differentiated instruction. Melesse exposed that most teachers teach diversified learners in the same classroom in a form of one approach without significantly addressing the learners' readiness, interests, and learning profile. Deringol and Davasligil (2020) intention was to investigate the effect of a differentiated mathematics instruction program developed for gifted and talented learners on their mathematical attitudes. It was found that a differentiated mathematics teaching program prepared by the researcher improved the mathematics attitude of gifted and talented learners.

2.3 Conceptions

Conception has been defined in different contexts. Mirian and Zulnaidi (2020) in their study investigated the level of teachers' conceptions of assessment and comparison between gender and academic qualifications. According to Thompson (1992) as cited in Mirian and Zulnaidi (2020), conception is 'the general mental structure, encompassing beliefs, meanings, concepts, propositions, rules, mental images, preferences, and the like' (p.239). Simply, conceptions represent what individuals understand, be acquainted with, believe, think, or experience about a domain at any one time. Frejd (2012) investigated teachers' conceptions about mathematical modelling and their experiences of working with modelling activities in Swedish upper secondary school, defined conceptions as broad notion or mental structure encompassing beliefs, meanings, concepts, propositions, rules, mental images and preferences. Frejd further clarified that the definition of conception encompasses beliefs, but also other notions like meanings, rules and preferences, and therefore conception is broader in the sense that the researcher cannot distinguish between beliefs and mental images. Likewise, conceptions are consolidated into a unitary construct of knowledge and beliefs, which represent a subcategory of the conceptions (Mirian & Zulnaidi, 2020). In the literature, the concept 'conception' and the concept 'belief'' are occasionally regarded to be the same, therefore, in this study, the terms beliefs and conceptions will be used interchangeable. Teachers' conceptions of Extended Mathematics Curriculum may be the effect of their beliefs and the meaning of Extended Mathematics Curriculum.

Wiest and Lamberg (2011) examined the fundamental issue of whether science discipline influences teachers' conceptions and enactment of inquiry. They used the term conceptions as an umbrella to represent three central and interrelated sub-constructs: dispositions, beliefs, and attitudes. Their results revealed that they got high reliability on multiple sub-constructs of teachers' conceptions within a single survey, including attitudes, disposition, and confidence in regards to mathematics and teaching. In other words, teachers can develop patterns of behaviour that are characteristics of their pedagogy. In some cases, these patterns may be manifestations of intentionally held ideas, beliefs, and preferences that act 'driving forces' in shaping the teachers' behaviour. The driving forces may be unconsciously held beliefs/conceptions that may have been carried out of the teacher's experience. Breslyn and McGinnis (2011) observed the fundamental issue of whether science discipline influences teachers' conceptions and enactment of inquiry, spotted conceptions as emerging from beliefs about teaching, learning and past experiences with inquiry similar to preservice training professional development, and past experiences doing inquiry will. Their findings suggested that disciplinary differences exist between National Board Certified Science Teachers (NBCST's) conceptions and enactment of inquiry. Furthermore, an individual teaching more than one discipline often holds different conceptions of inquiry depending on the discipline in which they were teaching. Therefore, in this study, conceptions will be viewed as the understandings and experiences that teachers have their role in LGCSE Extended Mathematics Curriculum and the measures towards teaching and learning of Extended Mathematics.

Furthermore, a study by Francis (2014) focused on beliefs as a significant area of the influence of beliefs on what is taught and learned. Francis defined beliefs as embodied conscious and unconscious ideas and thoughts about oneself, the world, and ones' position in it developed through membership in various social groups, which are considered by the individual to be true. It is therefore important to believe that in mathematics, teachers' conceptions, plays an important role in affecting their effectiveness as important executives between the subject and the learners. Teachers' conceptions of the Extended Mathematics Curriculum may result from their belief about differentiated curriculum and the meaning of the differentiated mathematics curriculum, particularly in Extended Mathematics Curriculum. This includes the curriculum design, the purpose and aims of the differentiated curriculum and how the implementers interpreted the curriculum intentions. Mapolelo and Akinsola (2015) suggested that mathematics teacher

education programmes should present pre-service teachers with understanding of conception of mathematics which may influence their teaching.

2.3.1 Conceptions held by mathematics teachers

Teachers may see the world through the lenses of their conceptions; alongside they interpret and act according to their understanding of the world (Mirian & Zulnaidi, 2020). Teachers may hold different beliefs/conceptions or the ideas in the teaching of mathematics especially when enacting new Extended Mathematics Curriculum. Some ideas mathematics teachers may hold can influence not only the curriculum change but also the instructional behaviour within the varied ability classrooms. Lam et al. (2013) examined teachers' conceptions of teaching interdisciplinary, and their experiences in implementing integrated curriculum, explained that it is through teachers' beliefs/conceptions about education, their knowledge, understanding of policies, and everyday experiences of practice that teachers understand curricular goals and learners' learning experiences. They further agreed that to better understand teachers' conceptions and curricular practices in relation to the demands of their professional context requires an in-depth examination of teachers' thinking and experience.

In their study, Mapolelo and Akinsola (2015) discussed research on teachers' mathematics knowledge, and explained that the significance of the teachers' conception of mathematics, although knowledge is important, has been known to have a significant impact on instructional practice. They concluded that mathematics teacher education programmes should provide pre-service teachers with awareness of conception of mathematics which may influence their teaching. The Aguilar-Gonzalez et al. (2019) study focused on understanding the characterisation of the knowledge that is put into play in the practice of a primary school teacher and how this characterisation deepens the conceptions about the teaching and learning of mathematics evidence. They emphasised that conceptions are elements from knowledge but closely linked to it in such a way that it permeates the knowledge that the teacher has in each of the sub domains. Muhtarom et al. (2019) also attested that there is a bond between one's beliefs/conceptions and knowledge. Similarly, in a qualitative study design by Lam et al. (2013) they illustrated that teachers' practice is influenced by a web of beliefs/conceptions and perspectives about curriculum and about education generally: however, beliefs about the nature of curriculum are only one aspect of the thinking that informs decisions about what to teach.

Yilmaz and Sahin (2011) studied pre-service teachers' beliefs about learning and intelligence as well as beliefs about the nature of reality, since they are all part of teaching and learning. They classified teachers' epistemological beliefs into traditional teaching and learning and constructivist teaching and learning. Case study aimed at describing and characterising the beliefs of teachers concerning the nature of mathematics. According to him 'if school mathematics and mathematicians' mathematics are to be reconciled then teachers must have an appreciation of the nature of mathematics that is akin to that of mathematicians' (Beswick, 2012, p.129). Furthermore, he identified three categories of teacher beliefs about the nature of mathematics that were commonly adopted and used which are the Instrumentalist view, the Platonist view and the Problem solving view. Amirali and Halai (2010) presented the same three different philosophical views for the nature of mathematics as Beswick.

For the purpose of this study, I looked at the nature of mathematics from Beswick (2012) and Amirali and Halai (2010) in the light of these three key components of a teacher's beliefs; the Problem-solving view, Platonist view, and instrumental view. In the Problem-solving view mathematics is regarded as a dynamic and creative human innovation. That is, the learning of mathematics is perceived as self-directed exploration of one's own interests. In the teaching of mathematics, it is the learner that needs to be in focus rather than the content. Teachers are seen as facilitators and their role is to make learners confident problem solvers. In Extended Mathematics, teachers teaching strategies should align with the problem-solving view of mathematics.

Under Problem-solving view, the Platonists view mathematics as a static, unified, pre-existing knowledge awaiting discovery. The structure of mathematical knowledge and the interconnections between various topics are of fundamental importance (Beswick, 2012). It implies that the learning of mathematics means understanding and adopting as existing knowledge structure (Viholainen et al., 2014). The teaching of mathematics needs to be content-focused but also emphasising active understanding. In this view, teachers are seen as explainers and are to make learners conceptually understand and see mathematics as a body of unified piece of information. On the contrary, Extended Mathematics Curriculum allows learners to discover learning on their own hence learner-centred approach is well thought-out as best approach to use. Instrumental view in mathematics however, is seen as gathering of facts, skills and rules to be used in the pursuance of some external end. Mathematical learning is the inactive reception of

knowledge and the adoption of different skills, (Viholainen et al., 2014) and teaching of mathematics needs to be content-focused, with an emphasis on performance. In this view, teachers see mathematical facts, rules and methods as separate things.

Different authors got different findings concerning conceptions held by mathematics teachers. Amirali and Halai (2010) study tried to answer, 'what do Pakistani mathematics teachers know about the nature of mathematics'? According to their findings, mathematics curriculum reforms in mainly parts of the world including Pakistan strongly suggested problem solving approaches to school mathematics and to mathematics teaching. The study by Yilmaz and Sahin (2011) showed that that pre-service teachers preferred constructivist teaching views more than traditional teaching. This correlated with their epistemological beliefs. Muhtarom et al. (2019) results showed that most of the knowledge of pre-service teachers is consistent with their beliefs and pre-service teachers' knowledge has been internalised into strong beliefs that affect their words and behaviours. The same thing can apply to teachers of Extended Mathematics Curriculum. The study by Senturk and Zeybek (2019) examined the relationship between teachers' teaching-learning conceptions and pedagogical competence perceptions. According to the findings of their research, teachers mostly had traditional teaching-learning conceptions and there was no significant relationship between their traditional teaching-learning conceptions. Cansiz and Cansiz (2015) idea of their study was to investigate the consistency between Preservice Science Teachers' (PSTs') epistemological views and their classroom practice. They concluded that there is a good coherence between PSTs' epistemological views and their classroom practice.

Moreover, Wanjala and Simiyu (2020) investigated secondary school mathematics teachers' conceptions of problem solving and their classroom practices, their findings exposed that generally, there was no significant correlation amongst teachers' conceptions about problem solving and their classroom practice. This study also confirmed that teachers tend to hold strong conceptions about problem solving that are consistent with the instrumental view. Similarly, these can relate to Extended Mathematics teachers. Gens and Erbas (2019) study examined secondary mathematics teachers' conceptions of mathematical literacy, which are important to consider when it is essential to address in designing and implementing effective approaches. They basically uncovered that teachers who participated in their study frequently expressed multiple and simultaneously held conceptions of mathematical literacy. This can imply that

teachers may have baffling and uncertain understandings of the nature of mathematical literacy or reflect richness in teachers' understanding of various aspects of mathematical literacy.

More to the point, Mirian and Zulnaidi (2020) qualitatively revealed that teachers' exhibit moderate levels of conceptions, significant differences exist across the academic qualifications on improvement and irrelevance based on qualifications. Teachers with PhD qualifications have more improvement and relevance than those with bachelor and master's degree holders. Taole (2013) study looked into what these conceptions are and how they may possibly influence curriculum implementation in the future. On the contrary, the findings showed that curriculum review remains foreign concept for most of the teachers as well as presenting challenges to their existing conceptions and beliefs about curriculum review practices. Taole further emphasised that teacher support contributes to the foundation of the success of every curriculum innovation. This clearly shows that teachers support is very important in implementing a new curriculum in order to prepare them to implement the curriculum well.

Chhabra and Baveja, (2012) focused on two major dimension; learners' conceptions and teachers' conceptions. They concluded that their study strongly verified the essential need for teachers to understand the mental world of their learners and shift to learners centred classroom processes beside commonly practiced teacher centred ones. Inversely, Yilmaz and Sahin (2011) pointed out that pre-service teachers' beliefs influence their opinions of teaching. That is, what one believes in, is often manifested into practices of the beholder of such ideas. The following section sketches the challenges with new curriculum or differentiated curriculum.

2.4 Challenges with new curriculum/differentiated curriculum

In recent years, investigation of the unproductive implementation of new curriculum reforms has had benefits of extensive interest (Bantwini & King-McKenzie, 2011). 'Teachers understanding of curriculum and how teachers implement- or fail to implement- the intended changes can have a significant impact on the outcome of those changes' (Lam et al., 2013, p.29). According to Maharajh et al. (2016), qualitatively revealed that despite the challenges facing Curriculum and Assessment Policy (CAPS), South Africa's education system all together is plagued by challenges. The literature in this study engaged its attention to a range of issues related to the challenges teachers face in the implementation of Extended Mathematics Curriculum. Teachers are the key pillars in the teaching and learning process. Without suspicion, the most important

person in the practice of curriculum implementation is the teacher. Teachers are the most important human resources in curriculum implementation since they are the ones who adopt and implement the ideas and aspirations of the designer. This suggests that success and failure of the Extended Mathematics Curriculum depends on Extended Mathematics teachers. Robison et al. (2014) discovered that although differentiated instructions is popular among a number of teachers; its application remains quiet complex to majority of them. As much as teachers were willing to implement differentiated instructions, they faced many challenges and had to find solutions by themselves. Their findings included lack of professional development, time constraints, how differentiation instruction meets the needs of all learners, the difficulties of learning how to initially implement differentiated instruction, and the belief that differentiated instruction is important for learner success. Similarly, Extended Mathematics Curriculum may present such challenges. There are a number of factors which affect teachers in implementing the curriculum and make it a challenge. The following factors will be discussed in relation to how they influence teachers in implementing a new curriculum, specifically, LGCSE Extended Mathematics Curriculum: teachers' development, workload of teachers, teachers change and lack of clarity about Extended Mathematics Curriculum.

Teachers need to develop professionally since professional development involves teachers' re-evaluation, update and widening of their responsibilities as transformation managers for the purpose of teaching and learning. Bantwini and King-McKenzie (2011) expanded on their work by examining the contextual interactions and understandings that give rise to the non-implementation of curriculum reforms. They viewed teachers' professional development as an answer in the curriculum reform development. Nicolae (2013) showed that most of the teachers consider professional experience ending as the first educational degree is obtained, not being aware of the effects of their field of profession. Nicolae further explained that teachers lightly take the fundamental need to be more developed in order to build the right strategies that should be implemented in a differentiated classroom. This suggests that professional development develops the necessary mathematics knowledge-base and skills teachers require bringing out their role effectively. Morgan (2014) investigated a case involving a child having difficulty learning and shows how differentiated instruction was used to help this learner learn. He agreed that even though differentiated instruction is designed to benefit every learner, it requires conversant and well organised teachers who can work very hard.

Mandukwini (2016) study intended to investigate the experiences and challenges faced by school stakeholders (School Management Team (SMT) and educators) regarding implementation of curriculum changes. According to Kyahurwa (2013) as cited in Mandukwini (2016), changes in education with regard to curriculum at all levels require teachers to expand their level of knowledge and skills. As Bantwini and King-McKenzie (2011) analysis revealed, the process of teacher development is often made complicated by the various needs that individual teachers have authority over and these needs demand teachers' sustained and ongoing professional development. They further explained that teachers' levels of professionalism play an important part especially in their learning. Similarly;

> 'teachers' professional learning is a complex process, which requires cognitive and emotional involvement of teachers in person and jointly, the ability and willingness to examine where each one stands in terms of convictions and beliefs and the perusal and enactment of appropriate alternatives for improvement or change' (Avalos, 2011, p.10).

If there is a content gap for instance, it would not be easy for a teacher to identify an area on which he/she needs development (Mandukwini, 2016). Nicolae (2013) speculated that we have to keep in mind that most of the teachers deliver differentiated instructions in their own way, thinking they are using differentiated strategies but are not. Therefore, formal structures such as courses and workshops may well serve some purpose like equipping teachers with skills regarding differentiated instructions (Avalos, 2011).

Mandukwini (2016) study concluded by pointing out that although SMTs and teachers try to act upon their roles and responsibilities to make sure that effective implantation of curriculum in their contexts, they still need training and constant support to perform certain aspects of their duties. Teachers concerned in the teaching of mathematics curriculum need to be trained to sufficiently work on a syllabus that accounts for differentiation in terms of learners' abilities regarding the difference between Core and Extended part of LGCSE mathematics 0178 (Letsie, 2019). Bantwini (2010) planned to explore how teachers perceive meanings of the Revised National Curriculum Statement contribute to its limited or non-implementation in classrooms. Bantwini further explained that teachers complained about their frequent meetings with the subject Advisors responsible for their professional development. Teachers are not affectionate when attending meetings with advisors. Teachers' development is not the only challenge that can

influence the success of enacting curriculum innovation; increasing further workload of teachers can be another challenge.

Teachers' workload presents a problem for our entire education system. Teachers are overloaded in the areas they are teaching (Bantwini, 2010). Work overload becomes a serious challenge to teachers who are teaching mathematics curriculum. Teachers feel it is necessary to differentiate their lessons for their learners while others do not like extra work and consider additional preparation out of the educational norm hence is not worth the time (Nicolae, 2013). Teachers do not want to manage their time to plan properly, or prepare their lessons at the last minute, which can lead to pressure as a result affects teaching and learning. These high stresses also contribute to their attendance in classes. According to Bantwini (2010) in South Africa, one of the teachers' common perceptions of the Revised National Curriculum Statement (RNCS) was that it was basically an overload of work for them and RNCS has a lot of paperwork, more than Curriculum 2005. He further explained that the new curriculum was viewed as overburdened with administrative work rather than being a simplified and updated curriculum intended to facilitate the goals of Outcomes-Based Education (OBE). The current study looked at how workload becomes a barrier for the implementation of the differentiated curriculum. Furthermore, the researcher also explored teachers' acceptance to change as a barrier in the implementation of the policy.

Resistance is a wake-up call concerning the complexities involved in the reform process and should not be ignored or treated as senseless (Bantwini & King-McKenzie, 2011), teachers do not respond in the same way when educational change occurs or is attempted (Hargreaves, 2005, as cited in Bantwini & King-McKenzie, 2011). Teachers, who do not offer learners an opportunity for discussion and learning on their own, discourage learners from having the opportunity to explain their ideas and react to the ideas of others, and do not challenge learners' thinking in Extended Mathematics. Learners who think mathematics is all about the "correct" answer will need support and must be encouraged to take risks. Most of the teachers, especially those with many years' experience, resist changing; they do not change their old teaching methods or practices. Normally, teachers have a tendency to teach the way they were taught (Mapolelo & Akinsola, 2015). Curriculum changes need to be reinforced and principals' role is to look out against any type of resistance from teachers (Mandukwini, 2016). Teachers' change

can be a possible obstacle to successful implementation of differentiated curriculum. The next discussion focused on lack of clarity about the new curriculum.

In his qualitative study Mandukwini (2016) found that teachers' lack of clarity can lead to unsuccessful innovation or implementation. The issues of policy clarity, is an origin for concern to the successful implementation of curriculum. Feelings of uncertainty and deep lack of understanding resulting from this worsened by a lack of ongoing professional development would ensure that teachers understood what was required from them (Bantwini, 2010). Introducing the term 'differentiation' and understanding the concepts of what involves a good lesson design, the misinterpretations ought to be removed so that teachers can develop a clear understanding of what responding to all learners' needs means (Nicolae, 2013). Teachers should be clear of what the Extended Mathematics Curriculum requires from them to avoid misinterpretation of the Extended curriculum. Teachers who are unfamiliar with the new teaching instructions bring confusion in teaching and learning of mathematics. Bantwini and King-McKenzie (2011) pointed out that there is a lack of understanding of the reforms accounted for the problems the teachers experienced in comprehending the way the curriculum was set and its implications, as well as their unfamiliarity with the new teaching approaches and methods suggested by the new curriculum policy. Similarly, Mandukwini (2016) agreed that the practicality of curriculum policy depends entirely on teachers' willingness to apply different methods to derive content meaning. Mandukwini further clarified that it requires teachers mastering the content and how affectionate they are. However, Extended Mathematics involves problem solving to place the focus on the learner making sense of mathematical ideas. That is, Extended Mathematics Curriculum proposed problem solving to allow learners to build up understanding and explain the processes used to arrive at solutions, rather than remembering and applying a set of procedures. Teachers need to be clear about the details of Extended Mathematics Curriculum.

2.5 Theoretical framework

The study was guided by the Concerns-Based Adoption Model (CBAM) developed in the 1970s by the Research and Development Centre for Teacher Education in Austin, Texas (Hall & Hord 1987). This study adapted CBAM from Hall and Hord (1987). The Concerns-Based Adoption Model is an exceptionally powerful tool for diagnosing teachers' implementation efforts by

tracking the progression of adopters' concerns and their behaviours related to innovation use (Mugweni, 2012). CBAM is a framework and set of tools for understanding and managing change in people and focuses on how people, such as teachers, parents, students and policy makers, take action to change (Hall & Hord 1987; Hord et al., (1987); Loucks-Horsley & Stiegelbauer 1991, as cited in Khoboli & O'toole, 2011). The Concerns-Based Adoption Model (CBAM) is based on the part of the process where most innovations are unsuccessful, individual decisions. Once the innovation, the environment, the change agent, and the plan are ready, the key is the intended adopter. Each user will try the innovation and make an independent decision, which makes that decision vital to the likelihood of innovation's success. CBAM is a process, providing teachers the opportunity to address their own needs and ideas. Each teacher will respond to a new program with exceptional conceptions or understandings, attitude and beliefs, and each teacher will use a new program differently.

In this study, the Concerns-Based Adoption Model (CBAM) provided a developmental framework for the role of teacher concerns related to conceptions and challenges of the new Extended Mathematics Curriculum. It is a multi-part model that examines the process people go through whenever they are engaging in an innovation that is a shift from previous practice (Al Shekaili, 2016). By identifying the stages of concern of teachers, staff developers and administrators can address these concerns to further facilitate change. CBAM research developed three major diagnostic dimensions: Stages of Concern (SoC), Levels of Use (LoU) and innovation configuration (IC). SoC measures the intensity of individual feelings and perceptions about an innovation; LoU demonstrates how well the staff members are using an innovation; and IC maps provide the overall picture of the operational components and serves as an exemplar to guide and focus staff efforts. The two diagnostic dimensions (stages of concern and levels of use) of the Concerns-Based Adoption Model (CBAM) levels were used as a framework for this study and they have diagnostic tools. In this study questionnaire with open-ended questions used to assist the researcher to find out teachers' conceptions and challenges of LGCSE Extended Mathematics was developed.

2.5.1 The stages of concern

The Stages of Concern (SoC) describe feelings that individuals experience in implementing an innovation. The SoC process includes a questionnaire, interview, and open-ended statements,

which allows innovation leaders to spot teachers' attitudes and beliefs toward a new program or initiative. Using the Stages of Concern, education leaders can assess and respond to the worries, attitudes, and perceptions of staff as they deal with the challenges of changing the way they work. With this knowledge, leaders can take actions to address individuals' precise concerns. Stages of Concern have three phases namely, self-concerns, task concerns and impact concerns. These three stages are expanded into seven dimensions of concerns that can vary in strength.

Figure 2.5 Shows Stages of Concern (Adapted from *Hall & Hord, 2001*, as cited in *Mugweni*, 2012)

The stages of concerns can be explained as follows:

Unconcerned: teachers are not worried about the change initiative because they have other things on their mind. Generally, the Unconcerned or Awareness stage look at teacher involvement with the innovation.

Self: teachers at the self-stage are concerned about how the change is affecting them. Normally, they are concerned about their ability to complete the tasks required for the change and what others will think of their ability.

Informational: teachers who are in this stage are aware of the change initiative and are beginning to seek information about the change. Informational spotlight is on gaining more information about the new curriculum such as, general characteristics, effects, components and requirements for new mathematics curriculum.

Personal: teachers at this stage are aware of the change initiative but are unaware of their role in the process. They may be considering personal conflicts such as values, morals, beliefs or may feel as though they are lacking the ability to implement the change initiative. That is, it deals with how innovation relates to the individual teacher that is, role, decision making, and consideration of potential conflict or lack of success (Mugweni, 2012).

Task: teachers that are experiencing task concerns are worried about the task itself rather than their ability. For example, a teacher at this stage may be concerned about all of the materials that are needed for the task. In addition, they may be concerned about the complexity of the task at hand.

Management: teachers at this stage are focusing on the process and the tasks involved for the innovation. They are also trying to understand the best approach to use the resources and information to implement the innovation.

Impact: Once a teacher is experiencing impact concerns, they have reached the point where they can see the impact the change is going to have on the students. They are more concerned about the outcome of the change and the effect it will have on student learning than the changes they will have to make or the resources that are needed for the change.

Consequence: teachers at this stage have their attention focused on the impact that the innovation will have on their students.

Collaboration: teachers at this stage have started working with others and discussing their opinions of the innovation. They are beginning to wonder how their colleagues are implementing the innovation and begin to seek this information.

Refocusing: Individuals at this stage are beginning to understand the universal benefits of the change. They now understand that the change was considered necessary and why it was

needed. Teachers at this level may begin to make changes to the innovation to achieve better outcomes.

Stages of Concern contain three phases, namely: self-concerns, task concerns and impact concerns. These three stages are prolonged into seven dimensions of concerns that can vary in strength (Mugweni, 2012). Self-concerns are low level concerns where users have become aware of the innovation then begin to gather the information about it and prepare for its use (Hosman & Cvetanoska, 2013). When educators initiate an innovation's use, they normally have intensive self-concerns (Stage 1, informational; Stage 2, personal), and feel like knowing more about the innovation and to discover any changes that the innovation might bring. Educators will also be keen to know time concerning implementation of the innovation, who will be charged, and how it will work. Even though educators may not say so openly, they might have intense personal concerns in the pioneering phases. Teachers might also worry about their ability, responsibility, and mistakes or changes to their work habits.

Task concerns are connected with the process and task-related matters. Task-concerns (Stage 3, management) can be most intense in the last part of innovation application (Hall & Hord, 2006). During the early stages of use, educators will regard management affairs such as how they meet various student needs and learning styles, maximize educational effects, prep-time before class, and how to organise classroom procedures and materials.

Impact concerns reflect a more advanced level of involvement than other concerns. When the innovation catches on across schools, and its influence is pervasive, educators may hold intense impact-concerns (Stage 4, consequence; Stage 5, collaboration; Stage 6, refocusing). Only a few may reach this level. Such concerns may include the results of activities regarding to the innovation, how well they work together, and how they might improve this application of the LGCSE Mathematics curriculum.

2.5.2 Levels of use

Levels of Use (LoU) describe teachers' behaviours as they experience and implement curriculum change. LoU spotlight is on the behaviours of teachers undergoing a change initiative and represents how teachers are acting in regard to the innovation. In addition, LoU outline contributes to being able to foresee what is probable to take place further down the road as the

change initiative continues to occur. Levels of use give explanation regarding the behavioural categories ranging from non-use to renewal.

LEVELS AND CATEGORIES OF LoU

NONUSERS

These are teachers who are not presently using the innovation. Researchers have identified four different types of nonusers:

Non-use: teachers at this level have little or no knowledge about the change initiative. At this point, they are making no effort to learn about the change initiative either. If they go to a training session for the change initiative, they are likely to sit in the back of the room grading papers or working on a different project rather than pay attention to what is being said.

Orientation: teachers at this level are starting to learn about the change initiative. They are just starting to gather and read available information about the initiative and are beginning to develop a belief on the change initiative.

Preparation: At this point, teachers have decided they are going to use the change initiative. They may be gathering the materials they will need for implementation, so they are prepared for using the innovation. In order to move from the orientation phase to the preparation phase, the individual must have a date set for when the change initiative will be implemented in their classroom.

Mechanical Use: During this phase, teachers have already implemented the new change initiative. However, at this point they are focusing on day-to-day use. These teachers are not spending much time reflecting on their implementation efforts, nor are they focusing on meeting the needs of their students. In a program evaluation we would not include these teachers' student data as part of the experimental or implementation group. Instead, they would be considered non-implementers.

USERS

These are teachers who have begun to use innovation. Researchers have identified four types of users:

Routine: teachers at this level have stabilised their use of the new change initiative. They have moved past the day-to-day implementation phase of those in the mechanical use level;

however, they are still giving little to no thought to the process of implementation and where they are in that process.

Refinement: teachers are beginning to consider implementing the change initiative at this level. They are beginning to vary their implementation approach with the hopes of better results.

Integration: During the integration phase, teachers are beginning to work together with one another. Through the collaboration, teachers make changes to the implementation of the change innovation with the hopes of having better results for their students. This stage is very vital and innovation leaders should do all they can to help and guide teachers to this stage.

Renewal: teachers at this stage are beginning to explore main changes to the innovation or may be replacing aspects of the innovation with something different. These teachers believe these changes with the students' needs at heart.

The levels of use interview tool help determine how well teachers, both individually and collectively, are using a program. In this study, interview was used to collect data to help the researcher to identify teachers' conceptions and challenges teachers face in implementing the new Extended Mathematics Curriculum.

The Concerns-Based Adoption Model addresses three basic assumptions. The theory focuses on the individual's concerns about innovation or change. In the case of this study, it refers to the teacher's concerns about the LGCSE Extended Mathematics as a subject area. It also addresses the particular way the innovation is delivered or implemented (how the LGCSE Extended Mathematics) is implemented by teachers. The CBAM looks at the adaptation of the innovation to the individual teacher (Hall & Hord, 2001). In the case of this study, it acts as a foundation in understanding the teachers' conceptions and challenges in implementation of the LGCSE Extended Mathematics Curriculum.

2.6 Conclusion

This chapter discussed differentiated curriculum, teachers' conceptions and challenges in implementing Extended Mathematics Curriculum. It further outlined the theoretical framework of the study. The chapter that follows discusses the methodology concerning this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Research methodology involves the specific procedures or techniques used to identify, select, process and analyse information about a topic. The research methodology anchors the researchers ameliorate the research process and provides an opportunity for a thorough study. Inclusive of the subject matter understanding, to inspire the ability to assess and use research outcomes with sensible self-confidence and in decision making and instil the ability to read and think critically (Igwenagu, 2016). The research methodology chapter answers two questions: How was the data collected? How was it analysed? Typically, methodologies include the use of different methods when exploring phenomena and addressing problems (Coy, 2019). The study intended to explore teacher's conceptions/understandings of the LGCSE Extended Mathematics Curriculum and challenges teachers face in implementation of Extended Mathematics. Therefore, the methodology of this study specifically encompassed concepts such as the nature of research, sampling, instrumentation and data collection, data analysis and ethical considerations.

3.2 Research approach

The purpose of this study was to investigate teachers' conceptions and challenges of Lesotho General Certificate of Secondary Education (LGCSE) Extended Mathematics. To accomplish the purpose of this study a qualitative study was appropriate to use. In this study the researcher used qualitative study since it encourages the understanding of human experiences and circumstances, individuals' cultures, beliefs, and standards (Kalu & Bwalya, 2017). Respondents are able to freely share their experiences, thoughts and feelings without constraint or inhibition on the phenomena. The researcher believes qualitative methods also offer a dynamic approach to research, allowing a researcher an opportunity to follow up on answers given by respondents in real time, generating valuable conversation around the subject.

Shakouri (2014) indicated that qualitative study is concerned with non-statistical methods of inquiry and analysis of social phenomena. Shakouri further, declared that qualitative researchers can gain a deeper insight in the respondents' beliefs, factors or situation. In this study, the researcher uncovered how teachers understand Extended Mathematics Curriculum,

and the challenges they faced in implementing Extended Mathematics Curriculum. Qualitative research can be adapted to any research context that is not about knowing 'how many', but rather the lived experiences of the participants in their naturalistic environment. The advantage of qualitative approaches is that researchers do not start with 'hypothesis' that needs to be proved, which can be rigid and constraining. Instead, a qualitative research approach is an open-ended approach that can be adapted and changed while the research is in progress, which boosts the quality of the data and insights generated. The researcher was concerned with teachers' conceptions/beliefs and challenges they face in the implementation of Extended Mathematics and trust to obtain data in which the values of a variable differ in kind rather than in quantity (Bordens & Abbott, 2011). In support of this study, the selection of approach is encouraged by the fact that the researcher was concerned with individuals' understanding rather than justification, with the subjective investigation of realism (Fouche & Schurink, 2011).

3.3 Research design

Qualitative research has various research designs. The researcher created a case study design suitable to use for this study. Case study can be defined in different ways, "the vital opinion being a type of study that focuses on a single unit, such as one individual, one group, one organisation, or one program", (Ary et al., 2010, p.454). "A case study is an in-depth description and analysis of a bounded system" (Merriam & Tisdell, 2016, p.37). Furthermore, "case studies are a step to action", they start in a world of action and contribute to it and their insights might be directly interpreted and laid to use: for individual self-development; for within-institutional feed-back; for formative evaluation; and educational policy making" (Cohen et al., 2018, p.379). What is common about these definitions is that case studies are based on an in-depth investigation of a single individual, group or event to explore the causes of Core principles.

According to Baskarada (2013), case study is a worthwhile research design, in several different scientific domains and has been regarded as a soft research method; it is really extraordinarily difficult to perform in practice. Case study engages an effort to describe relationships which exist in reality (Igwenagu, 2016). Case studies can be used to explore, describe and explain events or phenomenon in everyday contexts in which they occur. Yin (2002) defined case study as a contemporary phenomenon within its real life context, particularly when limits between a phenomenon and context are not clear and the researcher has slight

control over them (as cited in Yazan, 2015). That is, case study can be viewed as an empirical investigation that explores the case or cases addressing the “how” or “why” questions regarding phenomenon of interest. Merriam (1998) perceive qualitative case study as a demanding, holistic description and examination of confined phenomenon (as cited in Yazan, 2015). In this study, the case study allowed the researcher to investigate and explore teachers’ conceptions of LGCSE Extended Mathematics and challenges they faced in implementing Extended Mathematics thoroughly and deeply.

The researcher might use just one complex case study where one explores a single subject in depth or conduct multiple case studies to compare and illuminate different aspects of the research problem. Case studies have a trend to focus on qualitative data, typically combining data collection methods, for instance, interviews, field observations, and documents (Merriam & Tisdell, 2016), this study benefits from the use of multiple data collection techniques specifically, questionnaire, interview and observation.

In writing up the case study, a researcher needs to bring together all the relevant aspects to give a complete picture of the subject. How the researcher reports the findings depends on the type of research the researcher was doing. Some case studies are structured like a standard scientific paper or thesis, with separate sections or chapters for the methods, results and discussion. Researchers conducting case studies present a detailed report that builds on narratives, vignettes, tables, charts, figures, visual displays, and text (Ary et al., 2010). In this study, the reporting was written in a narrative style, aiming to explore the case from various angles and analysing its meanings and implications. The researcher, in all cases, should make sure to give appropriate details about the case. In this case, the researcher report was structured like a standard scientific paper or thesis.

3.4 Sampling

Sampling is very important to the researcher. Usually, the time, money, and effort involved do not permit a researcher to study all possible members of a population (Ary et al., 2010). The researcher opines that sampling allows a researcher to save time, money and collect richer data. Some participants will not respond to the first effort at contacting them, meaning researchers have invested more time for follow-up. Sampling saves money by allowing researchers to gather the same answers from a sample that they would receive from the population. Again, sampling

allows researchers to ask participants more questions and to gather richer data than does contacting everyone in a population. Due to these reasons, sampling of my study was based on those three factors. Ary and his colleagues explained further that sampling enables the researcher to study a portion of the population rather than the entire population.

There are various sampling techniques that a researcher can make use of to achieve the purpose of a study. Sampling depends on the type of study embarked on. There are two major types of sampling procedures available to researchers namely, probability and non-probability sampling (Merriam & Tisdell, 2016); Probability sampling involves sample selection in which the elements are drawn by chance procedures. In support of the purpose of this study probability sampling was not suitable to use because it is more time consuming, usually more expensive. It has higher complexity when selecting participants and can lead to selecting participants who cannot address the research questions.

Due to the above reasons, non-probability was appropriate to use. Non-probability sampling is a sampling technique where the samples are gathered in a process that does not give all the participants or units in the population equal likelihood of being included (Etikan et al., 2016). Given the nature of this study, in selecting teachers, purposive and convenience samplings were suitable to use as one of the non-probability sampling procedures.

Purposive sampling was used to select teachers who were teaching LGCSE Extended Mathematics. Purposive sampling is believed to be sufficient to provide utmost insight and understanding of what researcher is studying (Ary et al., 2010). They further made clear that researchers use their experience and knowledge to select a sample of participants that they believe can provide the relevant information about the issue. In this study teachers were purposively sampled because they can provide the relevant information. The teacher from school A is a 33 years old female with 8 years of teaching experience in Extended Mathematics Curriculum. She is a Grade 8, 9, 10A, 10B, 11, form D and E teacher. Form E class contained 55 learners (Core and Extended). The teacher from school B is a Grade 10, form D and E teacher. He is a 54 years old teacher with 21 years teaching experience and 7 years teaching experience in Extended Mathematics Curriculum. Form E class contained 46 learners and 4 learners doing Extended Mathematics.

Nevertheless, convenience and purposive sampling were used to select the schools. Convenience sampling enabled the researcher to choose a sample based on availability, time,

location, or easy access (Cohen et al., 2018). The convenience sample helped the researcher to gather useful data and information that would not be possible when using probability sampling techniques which need more formal access to the lists of participants. The two schools were purposively and conveniently chosen in Leribe district based on availability and accessibility to find out teachers' conceptions/understandings of Extended Mathematics and the challenges teachers faced in the implementation of LGCSE Extended Mathematics. School A is a government school which was established in 2008 as a combined school (primary and high school). The school is located on the outskirts of rural Leribe. Learners admitted to this school are from neighbouring villages. School B is a church school situated in rural Leribe, less than 3km from kolonyama. Learners attending this school are from different villages and Berea district.

3.5 Instrumentation and data collection

There are so many instruments that can be used to collect data in qualitative study. Instruments allow researchers to collect data that they want to collect in the research process. Case study researchers normally focus on documents, interviews, and observations, physical artefacts, archival records when collecting data (Yin 2002, as cited in Yazan, 2015). The aim of this study was to gain as thorough understanding as possible of the case and its context; therefore, this study used open-ended questionnaires, observation and structured interviews to collect data.

3.5.1 Questionnaire

A questionnaire's aim is to obtain facts and opinions about phenomena from people who are informed on the issue (de Vos et al., 2011). In the questionnaire, the researcher establishes what he or she wants to know to answer the research questions that drive the project and design questions which will allow data to be collected to answer research questions (Bryman, 2016). My study adopted an open-ended questionnaire to find out teachers' understandings of LGCSE mathematics curriculum and challenges teachers face in implementing LGCSE Extended Mathematics Curriculum. Open-ended questions usually allow participants to respond in their own words (Bordens & Abbott, 2011). The questionnaire was piloted in a different school. The teacher was not a participant in this study. The researcher is of the opinion that the purpose of the

pilot was to give the indication of what responses the researcher should expect and to adjust the tool if needed. There were no adjustments made to the questionnaire.

3.5.2 Interview

Different scholars have defined interviews differently. According to Cohen et al. (2018, p.506), “interviews are a widely used instrument for data collection”. They further clarified that interviews allow participants (interviewers and interviewees) to talk about their interpretations of the world in which they live, and to convey how they view situations from their perspective. Similarly, ‘the interview is a social relationship planned to switch information between the participants and the researcher’ (de Vos et al., 2011, p. 342). To achieve the purpose of this study, interviews were conducted to understand teachers’ conceptions of Extended Mathematics and challenges teachers face in implementing Extended Mathematics. If a researcher decides to use an interview, he or she has to choose whether to use structured or unstructured questioning design (Bordens & Abbott, 2011).

In unstructured interviews, questions to be asked, time to be allowed and response to be collected are not thought of in advance. Generally, questions are asked and participants provide answers in their own words. Unstructured interview relies on spontaneity and follow-up questioning in order to gather detailed information from a research project. However, responses from an unstructured interview may be more difficult to code and analyse (Bordens & Abbott, 2011).

Whereas, semi-structured interview can be viewed as a meeting in which the interviewer does not strictly follow a formalised list of questions. Instead, they will ask more open-ended questions, allowing for a discussion with the interviewee rather than a straightforward question and answer format. Semi-structured interview is designed to ascertain subjective responses from participants regarding a particular situation or phenomenon they have experienced (McIntosh & Morse, 2015). Because of the conversational tone, the participants may feel at ease to expand on experiences that will highlight the traits that make them a good fit for the question.

My study adopted structured interviews to find out teachers’ conceptions and challenges teachers face in implementing LGCSE mathematics curriculum. Structured interview is scheduled for the specific purpose of getting certain information from the subject and each respondent is asked the same set of questions, but with some latitude in the sequence, (Ary et al.,

2010**)**. Bryman (2016) agreed that structured interview comprises a host of questions intended for similar purposes. Unstructured and semi-structured interviews were not appropriate in view of the fact that unstructured interview completely has the risk of not eliciting from the researchers' topics or themes more strongly related to the research questions under consideration (Rabionet, 2011). Unstructured interview does not have power over the participants' response (McIntosh & Morse, 2015), while in semi-structured interview less experienced interviewers may have difficulty extracting all the necessary information without a set list of questions.

A well prepared and fruitful interview needs to be well structured. Therefore, a researcher had a well-planned schedule consisting of prepared questions for guidance. "The underlying theory is that if the questions are phrased correctly, they will uncover all the information relevant to the topic" (Qu & Dumay 2011, p.244). The interview questions were related to research questions such that responses elicit concise answers or answers from a list.

The interview questions allowed the researcher to investigate teachers' conceptions and challenges they face in the implementation of Extended Mathematics. Each interview took about 20 minutes and was conducted at teachers' schools. The interviews were audio recorded to allow the researcher to listen and relisten during the transcribing phase of the research. The audio recording provides the actual interview process. According to Ary et al. (2010), the benefit of audio recording is that it captures every word articulated during the interview, including comments by the researcher for later references. Ary and colleagues further clarified that tape-recording the interviews facilitates the subsequent analysis.

It is very important to test the instruments before conducting the actual study because this will help the researcher to identify the inadequacy of the instruments. Piloting allows the interview schedule to be rehearsed in mock conditions that closely approximate the actual to modify it before main data collection (McIntosh & Morse, 2015). The audio recording was used during piloting of the study to make sure that the equipment was in good condition when collecting data for the actual study, and (Rabionet, 2011) to help improve my instrumentation.

3.5.3 Observation

According to Clark et al. (2009), as cited in Cohen et al. (2018), observation is a resilient on face strength; it can offer rich contextual information, enable first-hand data to be collected, reveal mundane routines and activities, and can be able to offer an opportunity for detailing those

features that are verbal, non-verbal and physical research process which offers a researcher the opportunity to gather “live” data from naturally occurring social situations. As a matter of fact, observation may be regarded as the basis of everyday social life for most people; researchers are conscientious observers of behaviours and of the material surroundings (Ciesielska et al., 2018). They further clarified that researchers watch, evaluate, reveal conclusions, and make comments on interactions and relations. Observation is almost certainly the most regular and simplest method of data collection. It does not require much technical knowledge. By observing a phenomenon continuously, the researcher may get familiar with the observed phenomenon. He/she can be acquainted with their habits, likes, problems, perception, different activities and so many other things. In this study the researcher became familiarised with teachers’ conceptions of Extended Mathematics and challenges teachers face in the implementation of Extended Mathematics. The researcher depended on information provided by the respondents. These are indirect methods and here the researcher did not have any means to examine the accuracy of the data supplied to them. But in observation the observer can straight check the accuracy from the observed. He/she can apply different devices to test the reliability of their behaviour. So very often the data collected through observation is more reliable. The usage of observation as a main method of research potentially can produce more valid or reliable data than would otherwise be the case with mediated or inferential methods (Cohen et al., 2018).

Observation as a common method, is very easy, followed and accepted and is a more global type of observation than the systematic, structured observation used in quantitative research (Ary, et al. 2010), p.431). Observation can deal with phenomena which are not capable of giving verbal information about their behaviour, feeling and activities simply for the reason that they cannot speak. That is, observations likely record behaviour as it is (Merriam & Tisdell, 2016). Observation does not require the willingness of the people to provide different information about them. According to the researcher, often some respondents do not like to speak about themselves to an outsider. Some people do not have time or require skill to provide important information to the researcher. Although observation cannot always overcome such problems, still relatively speaking it requires less active co-operation and willingness of respondents. Observation is even possible without the knowledge of the respondents. It is a useful tool to check whether what the respondent said matches what happens in the practical situation.

According to Ciesielska et al. (2018), three types of observation can be used in different ways and in combination. They further explained that in participant observation, the researcher tries hard towards an immersion in a specific culture, if possible, for a longer period of time, in order to obtain an insider understanding of this culture either as a member or as a visitor. On the other hand, de Vos et al. (2011, p.329) specified that 'participant observation may be regarded as a research procedure that is typical of the qualitative paradigm, which implies that data cannot really be reduced to figures'. While in indirect observation, Ciesielska et al. (2018) pointed out that the researcher relies on observations done by other researchers on various types of documentation, recordings, or on auto-observation. This study used non-participant observation**,** in non-participant observation; the researcher tried to understand the world, relationships, and interactions in a new way, without common categorisations and evaluations (Ciesielska et al., 2018). In this study, the researcher observed how participants instructed Extended Mathematics Curriculum for the period of 40 to 120 minutes.

The participants' presentations were on different topics because they followed their scheme and records. The researcher did not want to cause any inconvenience, since the study was interested in how the participants instruct Extended Mathematics Curriculum irrespective of the topics. Video recording was used to capture the details of the teachers' lessons, in order to monitor whether their conceptions match what they do in the class. They were also used to check on challenges mentioned and not mentioned. In this study, video recording allowed a researcher to verify his/her observations. Video recording was also used in the pilot study to make certain that the equipment would work appropriately in the actual data collection.

Five stances towards observation have been recognised which are complete participant**,** participant as observer**,** observer as participant**,** complete observer and lastly collaborative partner (Ary et al., 2010). They further indicated that in a complete participant**,** the observer is a member of the group or context under study and focuses on the natural activity of the group without informing the group that it is under study. The observer is fully engaging with the participants and partakes in their activities. Completely participating observer tries to blend into the studied environment and to appropriate the group's lifestyle, customs, and even the way they perceive reality (Ciesielska et al., 2018). This can be very useful to understand a particular group. Participant as observer exposes his/her role as an observer, who can gain insider knowledge and understands the events in the same way as the participants (Cohen et al., 2018).

Here the researcher is fully engaged with the participants and is more of a friend or colleague than a neutral third party while there is interaction with participants. Observer as participant**,** researcher may interact with subjects enough to establish rapport but do not really become involved in the behaviours and activities of the group. There is some interaction with the participants, but the interaction is limited. Complete observer is typically hidden from the group or may be simply in a public setting observing public behaviour. In Collaborative partner**,** the observer and participants have an equal partnership in the research process. In this study, the researcher observed the classroom activities as an observer as participant because the researcher was not a member of the group and is interested in participating as a means for conducting better observation and hence generating a more complete understanding of the group's activities. In this study, the observations were used to check on whether teachers' conceptions match what they do in the class and check on challenges mentioned and not mentioned.

3.6 Data analysis

According to Ary et al. (2010, p.480), "data analysis is a process whereby researchers systematically search and organise data in order to increase their understanding of the data and to enable them to present what they have learned from others". They further explained that qualitative data normally take the structure of words such as descriptions, observations, impressions, and recordings. Data analysis comprises organising, accounting for and elucidating data, that is, making sense of data in terms of participants' definitions of the situation, noticing patterns, themes, groups and regularities (Cohen et al., 2018,). The objective is to understand difficult interactions in natural settings (Ary, at al., 2010) and a researcher investigating teacher reflection or teacher pathways into teaching might use narrative inquiry approaches.

Therefore, narrative analysis was used in this study to interrogate and make sense of the generated data (Hlalele et al. 2020). The questionnaire, interviews and observations data were analysed separately. The interview data was transcribed; transcriptions can give vital detail and an exact word for word record of the interview (Cohen et al., 2018). Then both questionnaire and interview data were coded and analysed by organising the data, selecting out ideas and concepts and organising them into categories and similar categories were sorted under one main over-arching theme. Similarly, the observation data was transcribed, coded and examined, key elements were identified, and elements were also organised and sequenced. Qualitative

observations rely on narrative or words to describe the setting, the behaviours, and the interactions. Findings were written in a narrative form that was rich in detail and description. These details provided a precise view of the conceptions and challenges of the participants regarding Extended Mathematics and how it is employed in their classrooms and then the story was retold which describes the individual participant's experiences. Re-storying helps the reader to understand the story by sequencing it in a logical order. The data was also analysed in comparative to research questions informing this study. Concerns-Based Adoption Model was used as a framework to analyse teacher's conceptions of Extended Mathematics and teachers' challenges in the implementation of LGCSE Extended Mathematics Curriculum**.**

3.7 Reliability

Reliability is highly important for any research. Reliability is concerned with the degree to which the measure would give consistent results each time it is used (Ary et al., 2010). That is, it refers to the uniformity of the results in research. For research to be considered reliable it should produce the similar results if repeated. In this study, the researcher questioned teachers for their own experiences before going on to ask prepared questions in order to test if the study fulfilled its predicted aims and certified that the results are due to the study and not any possible irrelevant variables. If the study is reliable, it can have positive implications for other areas, like, allowing the study to be used to develop further research in this field of mathematics. Again, the reliability of this study would extend globally since it would have an impact on the acceptance of the study.

3.8 Validity

Validity is 'regarded as essentially a demonstration that a particular instrument in fact measures what it intends, purports or claims to measure' (Cohen et al., 2018, p.243). If a research has high validity, which means it produces results that correspond to genuine properties, characteristics, and variations in the physical and social world. In the current study, to ensure the validity, researcher did a follow-up interview whenever doubtful about an explanation. Again, a researcher offered a short review to the participants at the end of the interview including my understanding, thus giving the participant a chance to comment.

Cohen further articulated that to ascertain validity on observations, a pilot was conducted to ensure that the observational categories themselves are appropriate, complete, discrete, and unambiguous and successfully operationalise the purposes of the research.

3.9 Ethical considerations

The letters seeking to collect data at the selected schools were delivered to the principals. The participants were made aware of the purpose of the study by their principals. The researcher assured the participants of the confidentiality of the data collected; participants remained anonymous and participants were told that they are free to withdraw from the study anytime without any consequences or explanations. Respondents were assured of confidentiality and anonymity by signing a confidentiality contract. The researcher believes that it is also comprehensive research practice to provide participants with an outline of the research results at the completion of the project and to follow through on this. The summary would be provided as soft or hard copy. According to Merriam and Tisdell (2016), the usual data collection methods of interviewing and of observation in qualitative research offer their personal ethical quandaries. The ethical issues were considered associated with interviews, such as protecting interviewee's information, decrease of unexpected harm, avoiding mistreatment and informing the participants about the nature of this study. This study also considered the above ethical considerations concerning the interviews and observations.

3.10 Conclusion

This chapter discussed research methodology adopted in the study. It highlighted the participants used as well as the instruments that were used to collect data. In particular, it used the framework given in chapter 2 to structure the research instruments. It explained how data was analysed and also gives ethical considerations as well as how the reliability and validity was ensured. The next chapter presents the findings of the study.

CHAPTER FOUR

PRESENTATION OF RESULTS AND ANALYSIS

4.1 Introduction

This chapter provided a presentation of the results based on data from the questionnaire, interviews and observations. In this section the researcher reports on the findings of the study based upon the information gathered. Data analysis involves examining, rearranging, modifying and transforming data to excerpt valuable information. Firstly, the presentation focused on analysis of teachers' conceptions/understandings of the two teachers and secondly, on teachers' challenges of LGCSE Extended Mathematics. Therefore, this chapter planned to answer the research questions and the data was presented according to the research questions.

The first section presents data from teachers in school A which is a government school. The data that follows is from a teacher in school B which is a church school. The teacher from School A is Miss Mafa and Mr. Thaba is from School B. Pseudonyms were used for these two teachers to ensure anonymity and confidentiality. Miss Mafa has eleven years of teaching experience while Mr. Thaba has twenty-one years teaching experience.

4.2 Conceptions/understandings of LGCSE Extended Mathematics Curriculum

4.2.1 Miss Mafa

In the questionnaire, Miss Mafas' responses revealed that Extended Mathematics is a good curriculum and learners benefit from it by getting good credits which help them to pursue mathematically related careers. She expressed her views as;

"It is a good curriculum which is meant for learners who want to pursue mathematically related careers and it offers good credits like A*, A and B, unlike Core curriculum. But less simple compared to COSC syllabus especially its assessment".

Her response suggested that Extended Mathematics Curriculum is different from Core curriculum and learners are different in terms of levels. Miss Mafa's view concurs with Tomlinson and Imbeau (2010) as clarified that differentiation makes learners to be prepared for higher education; thus ensuring that they learn the content, habits of mind, academic skills, and self-awareness essential for continuing learning. This clearly showed that she understands how

important Extended Mathematics is, especially for learners who want to specialise with mathematically related careers. She added that Extended Mathematics Curriculum is not complicated as compared to COSC curriculum especially when it comes to assessment. Miss Mafa also believed that there are teaching approaches involved when teaching Extended Mathematics. In summary she stated:

"It needs more time than COSC syllabus for it involves learner- centred approaches".

Her understanding of Extended Mathematics Curriculum showed that she is very somewhat knowledgeable about the approaches she is supposed to use during teaching which is learner-centred. That is, she is very clear that Extended Mathematics Curriculum is learner-centred curriculum which tries to adopt an array of learner-centred learning methods. Robinson et al. (2014) share similar opinions that a differentiated instruction involves knowing learners, understanding the curriculum, providing several pathways to learning, sharing accountability with learners and taking a flexible and reflective approach. Miss Mafa further expresses her conceptions of Extended Mathematics and expressed that as follows:

"The Extended curriculum is having more problem-solving than COSC syllabus".

The point raised here showed that she has an idea that Extended Mathematics engages more problem-solving as opposed to the COSC curriculum. According to the CBAM, she is experiencing a refocusing stage of concern (Hall & Hord, 2001, as cited in Mugweni, 2012), and she has some idea that problem solving works better in Extended Mathematics Curriculum. She again expressed her views as follows:

"It is more demanding than COSC because during revision as a teacher, I have to focus on four papers and most of the time I focus on basics leaving behind important concepts for Extended students. Therefore, I become bias".

This exposed that Extended Mathematics Curriculum is more challenging as opposed to COSC. She said she is not able to revise with both Core and Extended learners at the same time. Therefore, she decided on focusing on basic content and leaving behind the important concepts for learners taking Extended Mathematics. Agreeing with CBAM, she is experiencing an impact stage of concern; she has reached the point where she can see the impact the change is going to

have on the learners (Hall & Hord, 2001, as cited in Mugweni, 2012). Another conception she revealed is that she thinks Extended Mathematics Curriculum does not give out the intended purpose and put that as follows:

"……we still do not have many students that perform well and get good credits".

Miss Mafa's conception/understanding of Extended Mathematics revealed that it is a high quality curriculum but it does not provide the intended purpose since Extended learners do not obtain good credits. She is still experiencing the impact stage of concern (Hall & Hord, 2001, as cited in Mugweni, 2012). She is more concerned about the results of the change and the influence it will have on learning than the changes she will have to make or the resources that are needed for the change. She further expressed that the support that was given by the government during the implementation of this curriculum was only a workshop and put that in her words as follows;

"There was a three-day workshop and there was no follow up about how (to) the teachers were coping with the syllabus…."

Miss Mafa's response suggested that the workshop was not enough to conclude that teachers understand what the new curriculum is all about, hence, proposed that there should be more workshops after the implementation of the new curriculum to show more support. Supported by CBAM, she is at an informational stage of concern (Hall & Hord, 2001, as cited in Mugweni, 2012), she is prepared to know more about Extended Mathematics Curriculum. Miss Mafa further articulated her views and explained how she approaches Extended Mathematics Curriculum in the classroom and expressed that as follows:

"Mostly we are under pressure with time so it is teacher- centred, where I will be demonstrating the concept".

Clearly, Miss Mafa's understanding of Extended Mathematics indicated that she believes teacher-centred approach is the best approach to use in order to cover Extended Mathematics syllabus on time even though the approach is not suitable to use in Extended Mathematics Curriculum. Harmonising with CBAM, Miss Mafa is experiencing a consequence stage of concern, her interest focused on the influence that the innovation will have on her learners (Hall

& Hord, 2001, as cited in Mugweni, 2012). During observation, Miss Mafa's lesson revealed some of the good aspects of Extended Mathematics and this is seen in the excerpt below:

EXCERPT 1

Miss Mafa: We are going to remind ourselves on finding the gradient of a straight-line using change in y over change in x which is rise over run. So, am going to draw the Cartesian plane here. (Teacher draws the x-axis and y-axis on the graph board)

Let us draw this line y = x + 1. So, we have to find coordinates first so that we can draw the line. We have the x values; let us say our X value is 3 and 0 and -3.

X	***3***	***0***	***-3***
Y			

Table 4.2 Table for the function $y = x + 1$

So we are going to use this formula, Y = 3 + 1 is going to be how much?

Miss Mafa's lesson was all about calculating the gradient of the curve using a tangent. The analysis revealed that she reminded learners about the skills they used previously when calculating the gradient of a straight line and tried to engage them in this lesson. This aligns with the management stage of concern in CBAM; she is trying to understand the greatest approach to use and information to implement the innovation (Hall & Hord, 2001, in Mugweni, 2012).

In the interview, Miss Mafa presented her views by showing the benefits of Extended Mathematics Curriculum and expressed that as follows:

"It is very good… unlike COSC …. they like mathematics and they feel like they are capable……."

In relation to the benefits of Extended Mathematics Curriculum, her judgment is that learners show a sense of appreciation of Extended Mathematics. They enjoy doing Extended Mathematics and this Extended curriculum makes them feel like they are mathematicians therefore it is a very good curriculum. As seen in the earlier discussions, this understanding was also exposed in her questionnaire where she showed the benefits of Extended Mathematics Curriculum. Miss Mafa shared her views regarding the grading of Extended Mathematics as part of the goodness of this curriculum and expressed that as follows:

"…. grading of this syllabus ……. most of the students try to work hard to achieve like, A and A*……. this grading helps to work hard in order to get A*…. Grading is very, very good".

This illustrated that there is an understanding of admiration towards grading of Extended Mathematics, and this has brought motivation to learners and are eager to work hard in order to achieve better grades. According to Joseph et al. (2013, p.29), when a teacher differentiates instruction according to learners' existing interests, such learners become motivated and connect what is being taught with things they value. Supported by CBAM, Miss Mafa is experiencing a refocusing stage of concern, where she understands the general benefits of Extended Mathematics and that Extended Mathematics is needed and why it is needed (Hall & Hord, 2001, as cited in Mugweni, 2012). She further expressed the good aspects of Extended Mathematics Curriculum as follows:

"…… this one makes them to feel comfortable and they like mathematics……it came to their level".

Miss Mafa's perception of Extended Mathematics Curriculum showed that she believes Extended Mathematics Curriculum makes learners feel at ease when dealing with mathematics problems. During the interview, she further indicated that there are so many changes she would want to see in this curriculum and expressed that as follows:

"….. I would like to see our government to hire more mathematics teachers for Extended curriculum"

The suggestion here is that the government should appoint teachers so that the classes can be separated, and further analysis lets somebody see that the teaching of Core and Extended should be separated to simplify the teaching and enable teachers to reach each and every learner. Another change is that:

"There should be more workshops…. On how to teach it…… give us the skills on how to teach this Extended syllabus".

Reflection in this case is that she is willing to learn more about this curriculum in order to improve her teaching of Extended Mathematics Curriculum as seen in the discussions in her

questionnaire. Again, she is eager to acquire skills on how to approach Extended Mathematics Curriculum. Collaboration stage of concern in CBAM model supports that she is beginning to wonder how her colleagues are implementing Extended Mathematics (Hall & Hord, 2001, as cited in Mugweni, 2012). The next discussion would focus on Mr Thaba's conceptions/understandings of LGCSE Extended Mathematics.

4.2.2 Mr. Thaba

The questionnaire revealed that Mr. Thaba witnessed LGCSE Extended Mathematics Curriculum as a good curriculum concerning learners' mathematics linked courses during their tertiary level. Again, learners benefit more from this curriculum because it provides them with the necessary knowledge and skills. Mr. Thaba expressed his understanding further as follows:

"Extended Mathematics is a good curriculum as it gives learners good basics for mathematics related courses. It also broadens their mathematics knowledge and skills".

The inference is that he understands that Extended Mathematics Curriculum provides learners with necessary skills and knowledge which they require for better careers. Supported by CBAM, he is at a refocusing stage of concern and begins to understand the universal benefits of this change (Hall & Hord, 2001, as cited in Mugweni, 2012)**.** Another conception he has with reference to Extended Mathematics Curriculum importance is that it helps learners to apply mathematics concepts in other subjects and he expressed that as follows:

"… ... suitable/fit enough for mathematics related courses. Again Extended curriculum helps other courses such as agricultural, accounting"

Mr Thaba clearly understood that Extended Mathematics is a good curriculum especially when it comes to other subjects and those subjects benefit from it. Further analysis showed that other subjects like accounting depend particularly on Extended Mathematics. He is still experiencing a refocusing stage of concern (Hall & Hord, 2001, as cited in Mugweni, 2012), he has an idea how Extended Mathematics will benefit the learners. Mr Thaba's conceptions pertaining to Extended Mathematics Curriculum is that it is different from COSC curriculum and expressed his views as:

"This curriculum is a bit compatible to the COSC level curriculum; this is because it closes the gaps left between the tertiary level and the high school level".

Mr Thaba's conception here is that Extended Mathematics syllabus is greatly improved as compared to COSC curriculum, since it allows learners to meet the requirements in other universities other than National University of Lesotho. Mr Thaba's conception aligns with the refocusing stage of concern in CBAM, as he begins to be conscious of the universal benefits of the change and that the change was needed and why it was needed (Hall & Hord, 2001, as cited in Mugweni, 2012). He further expressed his views connected to Extended Mathematics concerning the teaching approaches as follows:

"I give the learners work before going to the classroom to teach. This makes them to wait for me with the questions".

In relation to the approach he uses in the classroom, Mr Thaba indicated that he gives learners some work so that they should be ready for the next lesson. This aligns with Deringol and Davasligil (2020) readiness may be influenced by factors such as previous experiences. This also shows that Mr Thaba believes that learners should discover things on their own and he is there to guide them and help them to learn. Mr Thaba response in the questionnaire further exposed another approach he uses in the implementation of Extended Mathematics Curriculum in the class is to group learners in terms of their abilities and he put this into words as follows:

"I also group learners according to their abilities, to be able to focus on the struggling learners".

Mr Thaba's understanding showed that in order to reach each and every learner in the class he has to divide them according to their learning abilities. Management stage of concern maintains that he is focusing on the process and the tasks involved for the innovation and trying to understand the best approach to use to implement the innovation (Hall & Hord, 2001, as cited in Mugweni, 2012). He also believed that Extended Mathematics Curriculum relates to other subjects and expressed that as follows:

"Extended curriculum helps other courses such agriculture, accounting … this helps our students in their daily lives".

The illustration here is that those other subjects rely on Extended Mathematics Curriculum. Furthermore, he made a claim about Extended Mathematics Curriculum, and declared that Extended Mathematics Curriculum serves the intended purpose and expressed that as follows:

"..... it helps in producing the better candidates. It also gives learners confidence in mathematics learning".

As Mr Thaba expressed that Extended Mathematics Curriculum is an excellent curriculum especially for developing learners' self-confidence, one may perhaps have expected learners to show that confidence when doing an exercise in the lesson. He is experiencing an impact stage of concern, he is more concerned about the outcome of the change and the effect it has on learner learning than the changes he has to make or the resources that are needed for the change (Hall & Hord, 2001, as cited in Mugweni, 2012). The next discussion presents observation data and the lesson was all about calculating the area of a triangle using sine formula. During observation, his lessons further expose his conceptions as follows:

EXCERPT 1

Mr Thaba: Do you still remember what we are going to study today? Do you still remembering what we are going to study today?

Raise up the hand! Raise the hand! Aoo, it is like you do not remember. Remember I said today we are going to deal with trigonometry…….

Having looked at Mr Thaba's part of his lesson, the reflection is that learners did not respond as he expected since he told them that the next day they are going to study about trigonometry. It seems like learners did not read about what they are going to learn and pay attention to what their teacher said yesterday. Therefore, the learners were not ready. As a result, they did not ask teacher any questions. Another part of the lesson was expressed as follows:

EXCERPT 2

TEACHER: let us turn to page 407 and go to exercise 21.7 and you do question 1. a, b and c, and that one is done by all of you. For Extended curriculum people, they should attempt question 3. a and b, and 4. (The learners were listening)

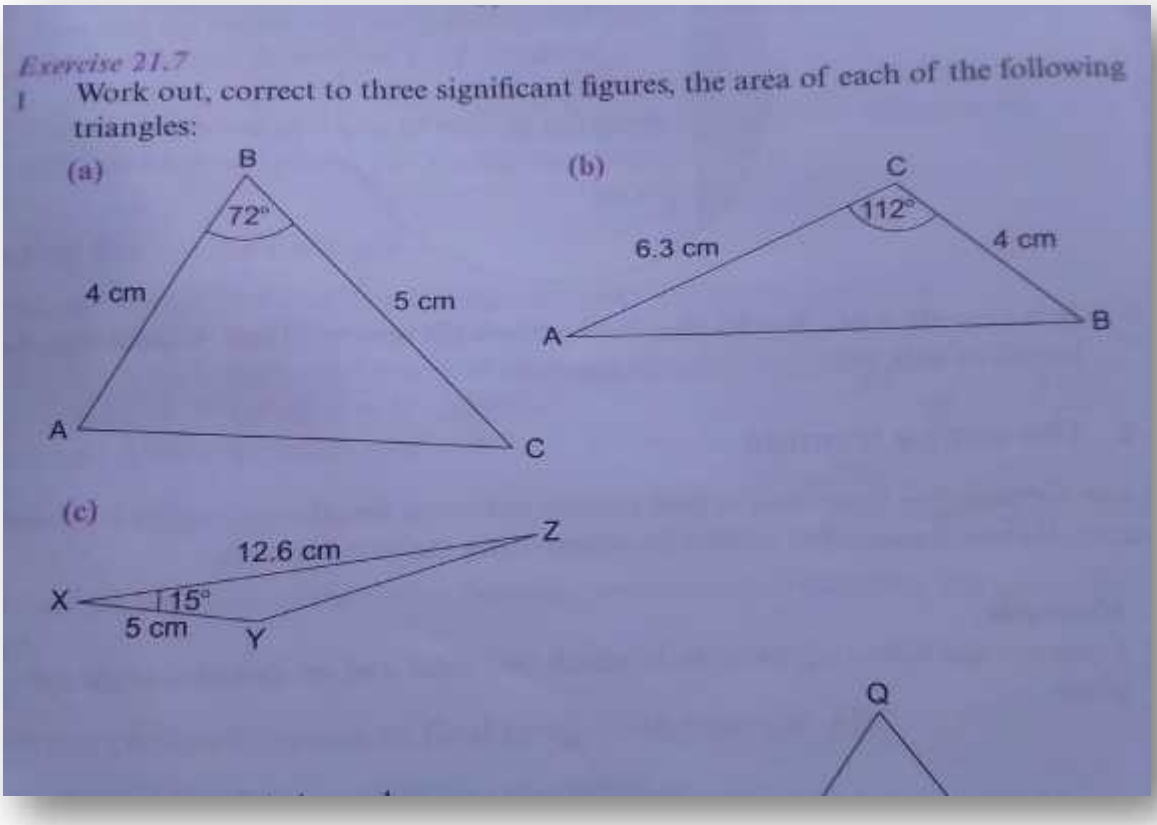


Figure 4.1 Exercise 21.7 (PRISIM 2000 Grade 11 & 12 Learner's Book)

The inference here is that Mr Thaba has no idea that the first question (exercise 21.7 number 1) is not at the level of Core learners and it is more challenging hence high-quality for Extended learners. The concept of trigonometric formula for the area of a triangle is not for Core learners but he engaged Core learners into this concept. This showed that he does not refer to the syllabus when preparing for the lessons. Again, this reflected that he tried to give the learners tiered exercises which is good based on learners needs and interests. Joseph et al. (2013) has the same opinion that product differentiation offers learners a range of pathways to show mastery of common learning goals.

In the interview with him, his responses enlighten that Extended Mathematics Curriculum has some good aspects and expressed that as follows:

"This curriculum enables students to do or further their studies on mathematics based courses…"

Mr Thaba believed that mathematics curriculum is necessary especially when it comes to learners who want to follow mathematically related careers. Besides this, he evidently showed that Extended Mathematics produces most excellent applicant and this also manifested during the interview with him and he voiced that as follows:

"It gives the learner enough capacity to handle all the mathematics problems in different areas as you know that mathematics is aimed at giving learner the skill to solve the problems…… to solve without any hesitation."

Without doubt, Extended Mathematics Curriculum entails problem solving. In the Extended Mathematics Curriculum learners become more skilled and are capable of facing any mathematics challenges, therefore helping them to become problem solvers. Furthermore, he expressed his conceptions about Extended Mathematics Curriculum regarding learners' discipline as thus:

"Learners of this curriculum are so disciplined…… because the way they are adopting the new life style…… makes them to be more focused".

His response recommended that Extended Mathematics Curriculum makes learners to be in charge of their learning, hence become more responsible. Also during the interview, he confidently spoke about Extended Mathematics Curriculum design and expressed his conception as follows:

"It was designed very good, very well because if you can look at chronology of the concept. I think it was done in a way that the topics that affects the other topics are put in front".

This clearly shows that he believes that Extended Mathematics Curriculum is well structured and the order of topics is put in such a way that they show a relationship and they connect to each other. Similarly, Justine (2017) viewed curriculum in terms of forms structured in relation to positive aims. He further suggested the use of this curriculum and expressed that as follows:

"I would like to recommend the use of this curriculum because this curriculum is very good……. I was going to make it binding to all students… even the students who are not going to further their studies on mathematics courses they need this curriculum for their own good".

He viewed Extended Mathematics Curriculum as a good one and is good for all learners despite their career courses. He is at a refocusing stage of concern and has ideas about something that would work better in this new curriculum (Hall & Hord, 2001, as cited in Mugweni, 2012). There are other changes he would like to see in this curriculum and he puts that in his own words as follows:

"…I have seen that that maybe the concepts that learners are given in this curriculum which is Extended, I think they left two of them behind by a mistake, according to me…. They have left calculus… and the topic of logarithms; they could have included that as a basic…"

The suggestion is that calculus and logarithm should be the part of Extended Mathematics Curriculum. Refinement level of use in CBAM maintains that he begins to give additional consideration to implement the change initiative (Hall & Hord, 2001, as cited in Mugweni, 2012), hence he considered that calculus and logarithms should be added to Extended Mathematics Curriculum.

As seen from the above findings pertaining to teachers' conceptions/understandings of LGCSE Extended Mathematics Curriculum, both teachers view LGCSE Extended Mathematics Curriculum as a good curriculum as learners gain from it. Again, they believe that Extended Mathematics Curriculum is a learner-centred curriculum but practically they used a teacher-centred approach during teaching and learners' participation was very limited. Miss Mafa emphasised that she mostly uses a teacher-centred approach and her justification goes with the way she was teaching. They showed a lack of capability and skills on how to deliver Extended content. Miss Mafa on the other hand lacks understanding when it comes to Extended Mathematics Curriculum since she cannot focus on both Core and Extended learners at the same time. However, both teachers view learning of Extended Mathematics as gathering of facts and rules and did not allow learners to solve mathematics problems on their own. Mr Thaba accepts as true that Extended Mathematics syllabus is structured very well since the concepts are arranged in such a way that they interconnect to each other and it is not easy to skip other

concepts. Conversely, Miss Mafa considered that Core and Extended learners should be taught separately. The next discussion will spotlight teachers' challenges of this curriculum.

4.3 Challenges teachers face in implementing LGCSE Extended Mathematics Curriculum

4.3.1 Miss Mafa

In the questionnaire Miss Mafa's responses signified that there are so many challenges she is facing in the implementation of this new curriculum. She specifically spotted out extra work and expressed that as follows:

"Workload due to being the only mathematics teacher……48 periods per week"

Miss Mafa feels like Extended Mathematics Curriculum brought an additional workload since she believes she must prepare two lessons, that is, one for Core and the other one for Extended learners at the same time. This further exemplifies that she is having 14 periods instead of 7 periods per week. Another challenge she is facing is clarity about the new mathematics syllabus and put into words as follows:

"I have a little understanding of the syllabus on how to teach it"

The indication is that Miss Mafa cannot handle the syllabus since she has little understanding about it. This aligns with CBAM, she is at non-use level of users; she has little or no knowledge about the change initiative and is making no effort to learn about the change initiative either (Hall & Hord, 2001, as cited in Mugweni, 2012). She is not going to be able to deliver Extended Mathematics content as expected and this is going to affect the teaching and learning of Extended Mathematics. This is also seen in excerpt 2 where she introduced the Extended concept to both Core and Extended learners. She clearly does not know what to do with the Core learners and which concepts are for- Core learners and vice versa. She put that in words as follows:

"It is not easy to cater for both Core and Extended students"

This attested beyond doubt that she is not able to teach learners according to their abilities and interests, but the new curriculum expects her to consider their abilities and interests. This supports the task stage of concern; at this stage Miss Mafa is worried about the task itself

rather than her ability that is she is concerned about the complexity of the task at hand (Hall & Hord, 2001, as cited in Mugweni, 2012). This response also shows that Miss Mafa cannot prepare a lesson which provides for both Core and Extended learners. That is, she cannot organise the content according to learners' abilities. The finding coincides with Melesse (2015), where Melesse exposed that most teachers teach diversified learners in the same classroom in a form of one approach without significantly addressing the learners' interests. This showed that Miss Mafa needs help to develop professionally hence she cannot structure her lessons in such a way that all learners are catered for. Once more, this disclosed that she is not able to reach all learners with varied abilities in the class. Another challenge she is facing when implementing Extended Mathematics is:

"Teaching of both Core and Extended in the same class. It is not easy to introduce the concept in class of both Core and Extended".

Miss Mafa's response suggested that Core learners should be taught in separate classrooms. Again, this revealed that she feels that teaching both Core and Extended in the same class is an obstacle since she cannot cater for both Core and Extended learners. Therefore, she uses teacher-centred approach when teaching Extended Mathematics and she put that in word as follows:

"Mostly …… it is teacher-centred, where I will be the one demonstrating the concept".

Habitually, Miss Mafa uses a teacher-centred approach in the classroom. Again, this presented that Miss Mafa is not able to apply learner-centred approaches during teaching. She further expressed her views as follows:

"They are many in class so I will have to use it to move fast….so I have to use teacher- centred more than learners-centred which is what our Extended syllabus needs".

The implication is that; time is not on her side since she has a large class group so she has to use a teacher- centred approach to teach. She is at impact stage of concern, where she is more concerned about the outcome of the change and the effect it will have on learners' learning than the changes they will have to make or the resources that are needed for the change (Hall & Hord,

2001, as cited in Mugweni, 2012). That is, she uses a teacher-centred approach with the intention of covering the syllabus on time regardless of the learners understanding the concepts. In the observation, some of the challenges she is facing manifested as follows:

EXCERPT 1

Miss Mafa: We are going to remind ourselves on finding the gradient of a straight line using change in y/change in x which is rise/run. So am going to draw the Cartesian plane here. (Teacher draws the x-axis and y-axis on the graph board)

Let draw this line y = x + 1. So we have to find coordinates first so that we can draw the line. We have the x values; let us say our X value is 3 and 0 and -3.

X	***3***	***0***	***-3***
Y			

Table 4.3 Table for the function *y = x + 1*

So we are going to use this formula, Y = 3 + 1 is going to be how much?

Learners: 4

Miss Mafa: Then 0 + 1 =?

Learners: 1

Miss Mafa: -3 + 1

Learners: -2

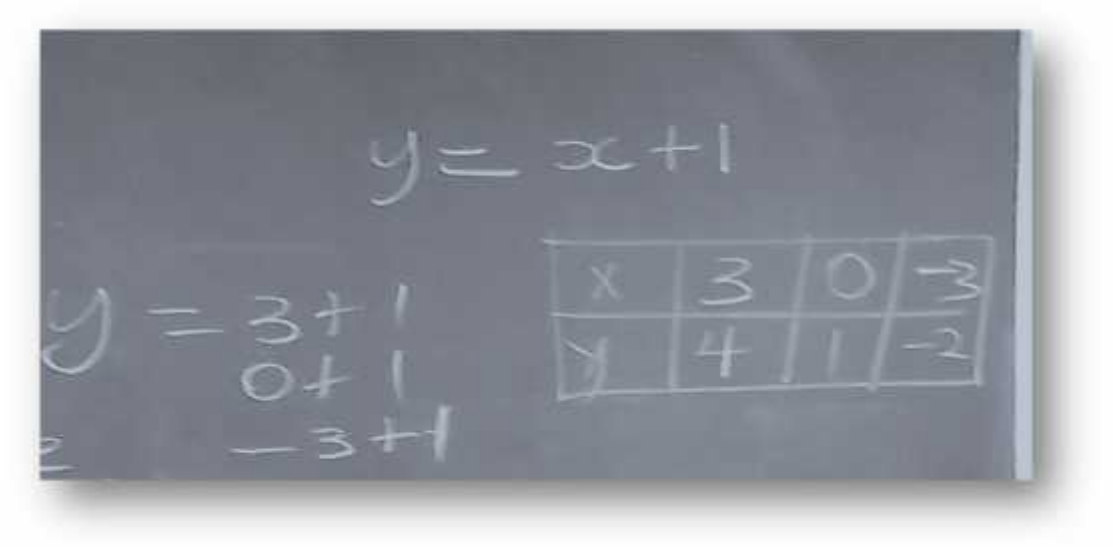


Figure 4.2 Table for ordered pairs or coordinates

(Teacher plot the points on the Cartesian plane)

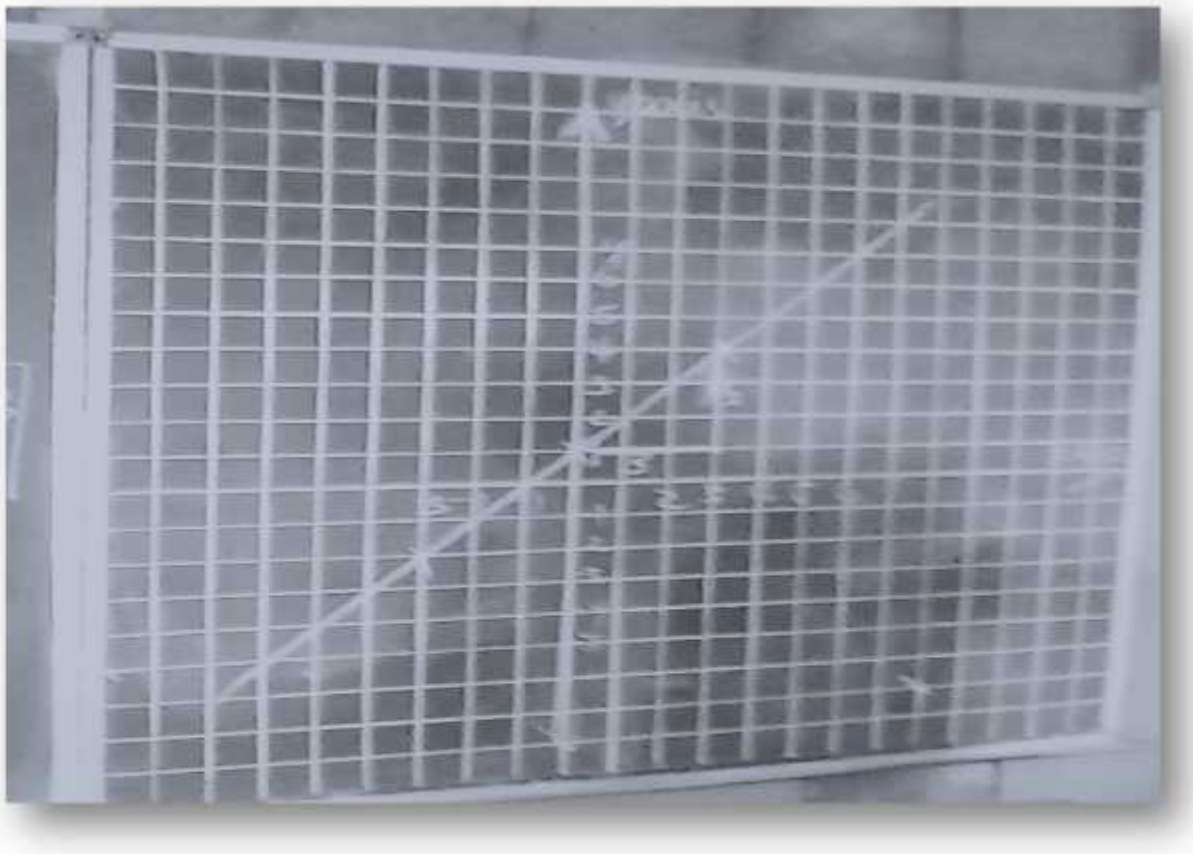


Figure 4.3 Equation of a straight line, Y = x + 1

We are going to use this line to change in y over change in x which is rise over run to find the gradient of this line. Let us start to this point (3.4) to this one which is (0, 1). When going to this point to this point, we are going to say your rise is going to be 3; we are going to draw something like a triangle. Then it is 3, 3. This is going to be 3/3 and 3 divided by 3 is 1. So the gradient is 1.

M = Rise/ Run

= 3/3

= 1

In this lesson most of the talking was done by the teacher and writing on the chalkboard. Learners were not even asking questions where they did not understand to get more clarification. The lesson centred on the teacher. Learners were expected to be engaged in the lesson and teacher to help learners to develop their abilities. Some of the challenges she has, were uncovered in his lesson during observation as follows:

EXCERPT 2

CONCEPT: FINDING THE GRADIENT OF A CURVE AT A POINT

Miss Mafa: Let's move quickly to the quadratic equations. We are going to find the gradient of the quadratic equation or we are going to draw the quadratic equation here whereby Y= x^2+3. (Teacher was drawing x-axis and y-axis on the graph board)

For plotting out this points we will have to find our values of X, lets' quickly find the values of Y. Let's find Y values. We are still going to apply the same principle when we were finding for coordinates of the linear equation and this one is a quadratic equation.

Y = x^2 + 3

X	***2***	***1***	***0***	***-1***	***-2***
Y					

Table 4.4 Table for the function Y= x^2 + 1

So let us take 0. We are going to say $0^2 + 3 = ?$

Learners: 3

Miss Mafa: then what about $1^2 + 3 = ?$ The answer will be how much?

Learners: 4

Miss Mafa: $2^2 + 3 = 7$, $-1^2 + 3 = ?$

Learners: 4

Miss Mafa: $-2^2 + 3 = ?$

Learners: 7

Miss Mafa: (Teacher was filling the table as the learners were giving the answers)

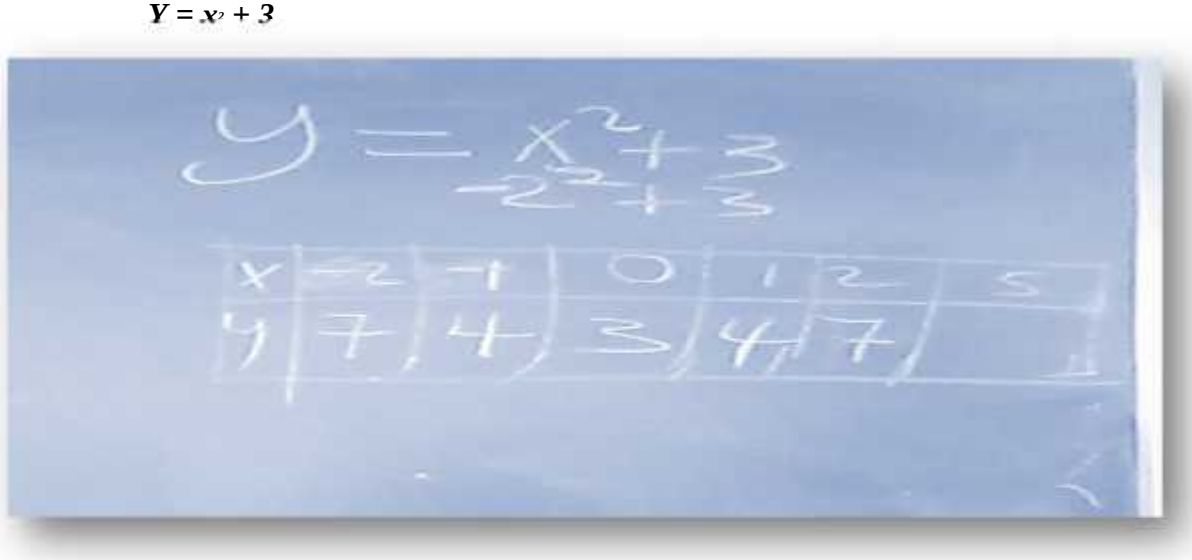


Figure 4.4 Table for ordered pairs or coordinates

Miss Mafa: (Teacher plots the points on her own on the graph board). (0,3), (1,4), (2,7), (-1,4), (-2,7). We are going to make a smooth curve and we do not have to use a ruler.

Figure 4.5 The graph of Y= x^2 + 1

So we are going to use this graph to find the gradient but finding the gradient we are going to use a tangent. Tangent is a line that is a straight line that touches graph at a point. We are going to draw it in such a way that it touches a curve at a particular point. For example; I am going to draw it here (-1, 4). So we have seen that we can find the equation of the straight line by using change in y over change in x. so we are going to use that way of finding gradient meaning we are going to use rise/run to find the gradient of this tangent. We can make another one this side (right side). (Teacher draws another tangent on the right side of the graph). So we are going to find the gradient of the line that means, if I check correctly, it means we can say, your rise (y_2-y_1) is going to be how much?

Learners: 1

Miss Mafa: Run (x_2-x_1) is how much?

Learners: 1

Miss Mafa: Is it going to be + 1?

Learners: Run is -1, rise is 1

Miss Mafa: M = RISE/RUN

= 1/-1

= -1

This reflected that Miss Mafa is not skilled enough to introduce Extended concepts in the class while Core learners are still in the class. She introduced the concept which is meant for Extended learners to both Core and Extended learners. Core learners were also part of this activity. The excerpt above also showed that even though she tried to involve learners in this lesson most of the practical work was done by her; she plotted the points and drew the graph herself. She is at a personal stage of concern; she is aware of the change initiative but unaware of her role in the process. She is considering personal conflicts or may feel as though she is lacking the ability to implement the change initiative. She used a demonstration method all the time. In her case, there were more than fifty learners in the class and some of the procedures may not be demonstrated clearly since there was no space for her to go around during teaching and some learners were far from the chalkboard those who were at the back seats.

In the interview she strongly stated that her belief is that Extended Mathematics Curriculum is an additional workload. She articulated that as follows in the interview:

"…… I teach from grade 8 to form E so it has brought a very big load".

There is no sense of appreciation of Extended Mathematics Curriculum since it has carried an additional workload as a challenge especially in her school where she is the only mathematics teacher. She further expressed her different challenge as follows:

"They are many in class so I will have to use it to move fast….so I have to use teacher- centred more than learner- centred which is what our Extended syllabus needs".

Miss Mafa's response showed that time is not on her side in view of the fact that she has a large class group, so she has to use a teacher-centred approach to teach. Her intention of using a teacher- centred approach is to cover up the syllabus on time regardless of the learners understanding the concepts. Supported by routine level of use in CBAM, she is not ready to alter

how the innovation is used (Hall & Hord, 2001, as cited in Mugweni, 2012). This is also seen during observation and in the questionnaire where she truthfully stated that she uses a teacher-centred approach frequently. She further clarified why she uses teacher-centred approach and expressed that as follows:

"We need to give students an opportunity to teach for themselves, but the problem is that they take too long so I will have to many times apply a teacher- centred method".

Her response exposed that she sees learner-centred approach as time consuming, hence she opts for teacher-centred approach all the time. She further expressed another challenge she is facing challenge as follows:

"Lack of teaching materials (textbooks for the students)"

The findings showed a deep concern that textbooks are not enough for the learners. Lastly, in the interview she expressed her closing challenge as thus:

"When am having problem with anything with my teaching, there is no way I can consult the other teacher to help so that we can be able to solve the problem, so I have to do it alone…"

Miss Mafa's reaction showed that there is no one to help her when she comes across problems/challenges at her school. Mr Thaba also has challenges when implementing this curriculum and the next discussion centred on his challenges when implementing Extended Mathematics Curriculum.

4.3.2 Mr Thaba

When it comes to challenges Mr Thaba faces in implementing LGCSE Extended Mathematics Curriculum, Mr Thaba emotionally indicated that there are some challenges he is facing when implementing Extended Mathematics Curriculum. He declared that the challenge he is facing is resistance to change when implementing LGCSE Extended Mathematics Curriculum. In a questionnaire Mr Thaba expressed this as follows:

"….. We have so called slow learners. Teaching mathematics content in particular Extended, you may find that this kind of learners (slow learners) take much time to understand, so you

need to take enough time to make them understand the content so sometimes we lose patience. Then we just move on, at sometimes we just trace the learners that understand quickly then after identifying/ recognising that they understand we just move on in respective of what happens about those slow learners".

The investigation revealed that Mr Thaba is not willing to change his old habit and face new situations. Mr Thaba during the teaching and learning process focused on fast learners leaving behind slow learners not bearing in mind what happens to slow learners. A different challenge Mr Thaba is facing is lack of clarity about the differentiated curriculum and he expressed that as follows:

"It is difficult to focus on the two groups at the same time. When you focus on one group with a task and continue helping the other group, one of the groups loses focus and do not do the work".

The response indicates that Mr Thaba is not able to accommodate both Core and Extended learners. According to CBAM, the task stage of concern supports that he is worried about the task itself rather than his ability (Hall & Hord, 2001, as cited in Mugweni, 2012). A different challenge that Mr Thaba is facing is lack of content knowledge and he articulated that as follows:

"…. mastering of the content you find that some of the topics as a teacher you don't master them that much so that might be the limitation in terms of giving a learner enough knowledge on this content since you yourself you don't master the content very well".

Mr Thaba believes that Extended Mathematics teachers should be professionally competent when it comes to Extended Mathematics Curriculum content. For example, if a teacher is not conversant with mathematics content especially in topics such as probability, then learners' understanding of Extended Mathematics content is also restricted. Morgan (2014) agreed that even though differentiated instruction is designed to benefit every learner, it requires conversant and well organised teachers who can work very hard. He further stated one more challenge and he expressed that as follows:

"The syllabus itself is also an obstacle…. … the way it was designed is so long, its unfishable because the kind of content you have to cover and the weight of content……"

The analysis exposed that Mr Thaba considered the new syllabus as a problem by itself and is not easy to cover the whole syllabus within the stipulated time. His consideration is in line with an impact stage of concern of CBAM; he can see the influence the change is going to have on the learners (Hall & Hord, 2001, as cited in Mugweni, 2012). According to him, the content is too much, hence he finds it a time consuming curriculum. As he goes on, his observation conveyed lack of clarity about Extended Mathematics as a challenge and his lesson expressed it as follows:

EXCERPT 3

Mr Thaba: ***If we have a triangle which is not right angled triangle we may be requested to calculate the area of such a triangle. If it is not a right angled triangle we are not supposed to use either the three trigonometric ratios or the area formula of the triangle which state A = ½bh. That formula also works if we have right angled triangle but if we don't have right angled triangle, what are we supposed to use? We are supposed to devise a formula that can be used on that. We are going to devise it right now. Let me say it has been devised or derived long time ago, alright?***

Learners: Yes, sir!

Mr Thaba: Now in trying to come up with a solution in this matter now, when they devise this kind of formula they look at this kind of triangle. They said suppose we have

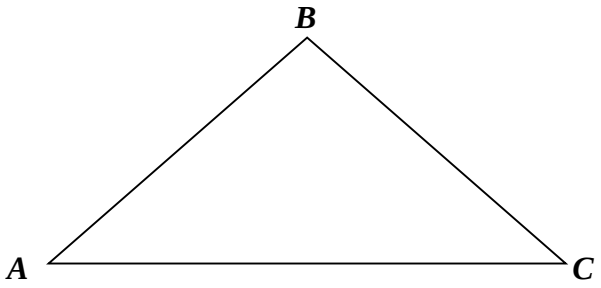


Figure 4.6 Triangle ABC

Now as we know the side opposite to angle B is?

Learners: Small b.

Mr Thaba: Side opposite to A?

Learners: Small a.

Mr Thaba: Side opposite to C?

Learners: Small c.

Mr Thaba: (Teacher was labelling the sides.)

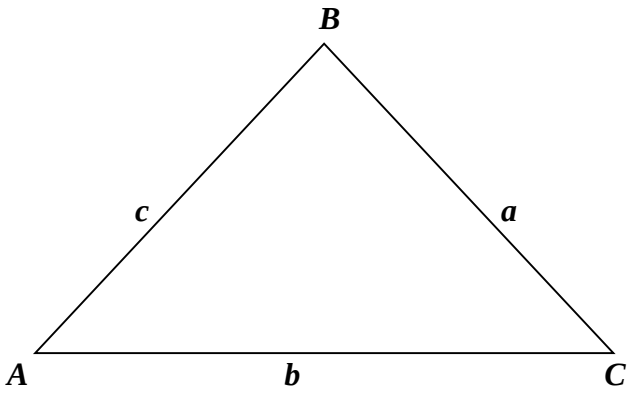


Figure 4.7 Triangle ABC with lengths a, b and c.

Because the formula of the area of triangle needs the height or has the height component this one does not have the height, if you can see?

Learners: Yes, sir!

Mr Thaba: let us bring the height into this, by doing what? By constructing it (He draws the line perpendicular to AC), so we construct the height like this,

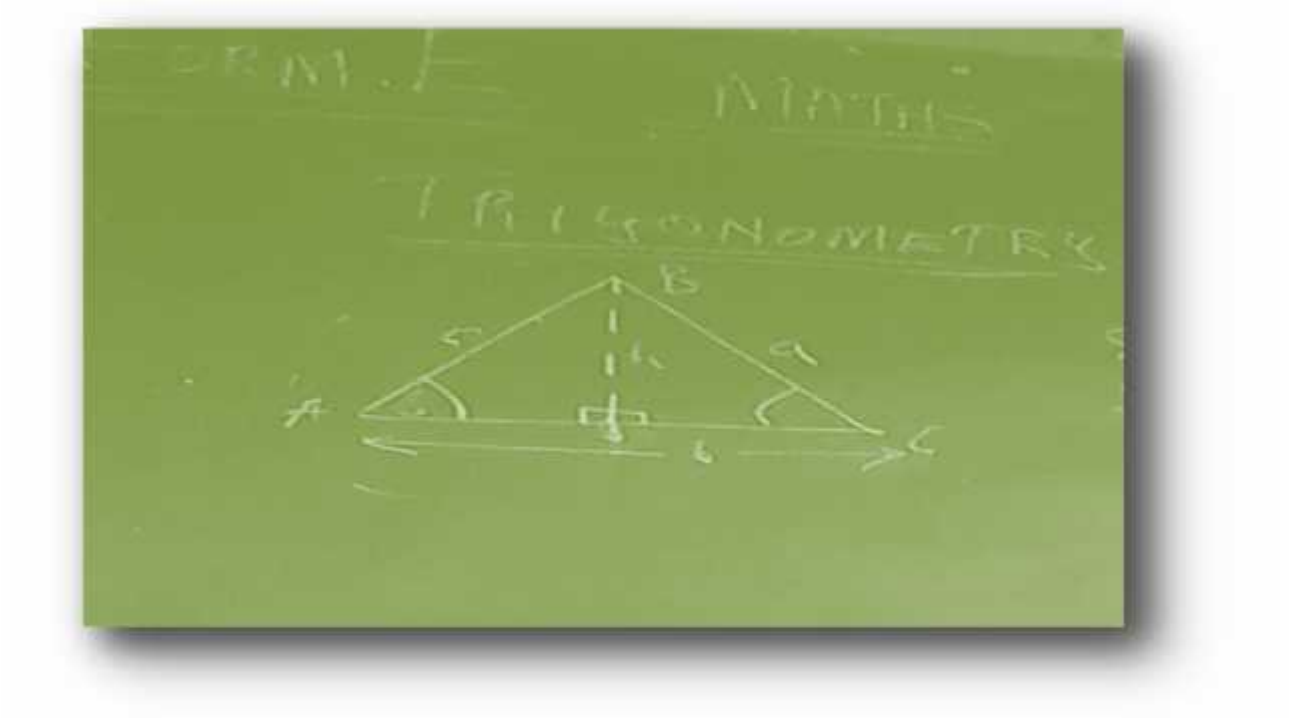


Figure 4.8 Triangle ABC with height (h)

So when constructing height, by so doing we have divided the triangle into two kinds of smaller triangle.

The above excerpt suggested that he did not focus on Extended learners only. The concept he introduced was suitable for Extended learners only, but Core learners took part as well. This also showed that he does not know what to do with Core learners when dealing with concepts in the Extended Mathematics. Another challenge he is facing is teachers' development, and this is also seen during class observation, and he expressed that as follows:

EXCERPT 4

Mr Thaba: Good morning everyone!

Learners: Morning sir!

Mr Thaba: How are you?

Learners: Fine how are you?

Mr Thaba: Am fine, thank you! Do you still remember what we are going to study today? Do you still remembering what we are going to study today? Rise up the hand! Raise

the hand! Aoo, it is like you do not remember. Remember I said today we are going to deal with trigonometry because we were on the trigonometry already where we talked about trigonometric ratios;

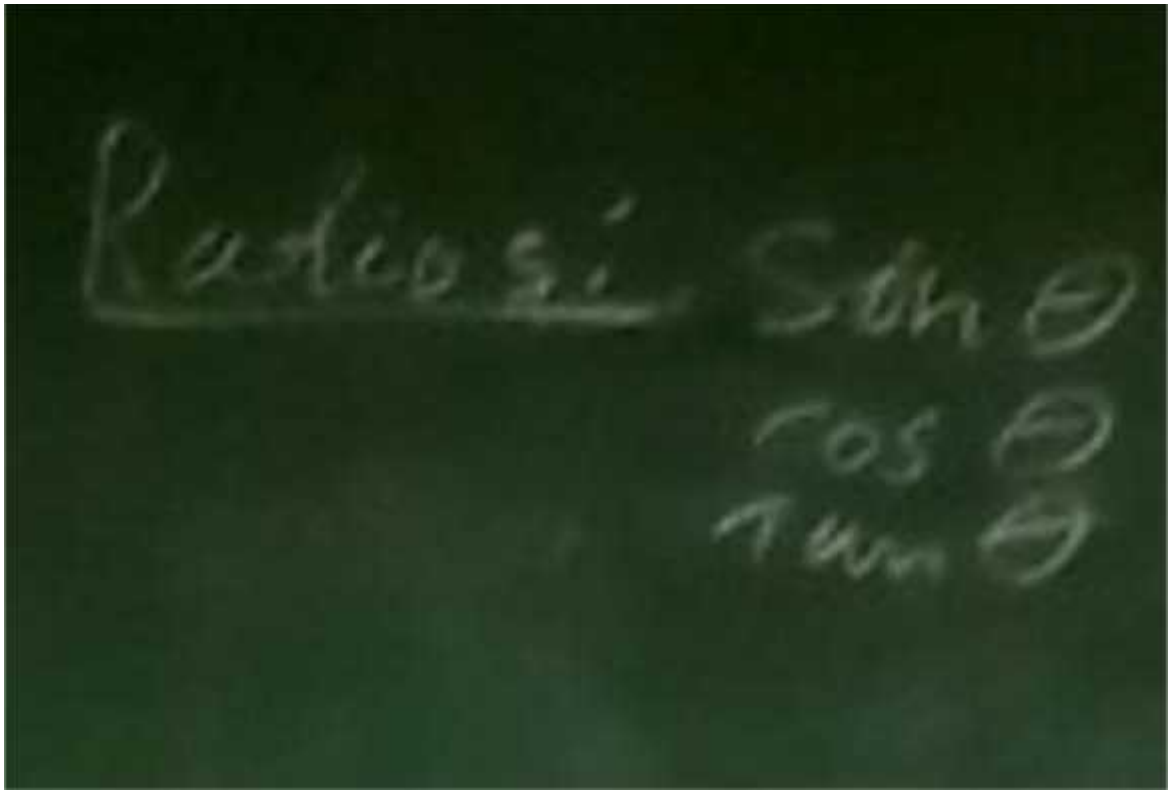


Figure 4.9 Trigonometric ratios

This thing (trigonometric ratios) operates if and only if we have a right angled triangle. They only operate if we are dealing with right angled triangle only. Besides that, these three trigonometric ratios do not work or are not supposed to be used.

His lesson revealed that he is not giving learners proper information because he wrote trigonometric ratios as **Sin θ, Cos θ, and tan θ.** He did not explain to learners why **Sin θ, cos θ, and tan θ** are called trigonometric ratios. This also shows that the learners might take this information as correct because they did not question that and just listen to their teacher. The way he delivered the information and improper mathematics language can cause misunderstanding to learners.

In the interview, Mr Thaba clearly stated that when implementing Extended Mathematics Curriculum, he has some challenges and expressed one of the challenges as follows:

"Not having enough resources to teach effectively".

This then means that financially the school cannot afford to buy its own textbooks for learners since the government cannot give the supplementary textbooks on time as the number of learners increases year after year. This was seen during the lesson where learners shared textbooks. This suggests that the resources are not sufficient to teach and this makes learning intolerable. He expressed another challenge as thus:

"In itself makes it difficult to divide mathematics learners into two groups maybe treating the Extended students somewhere at their own time"

This response showed that he feels like Core and Extended lessons can be separated learners like having Core learners and Extended learners in their own class. In addition, he made a remarkable statement during an interview about the challenges he is facing in this new curriculum and sorrowfully pointed out that:

"Few students are doing this curriculum …. I am enforced to treat them concurrently…I have only four students who are doing this curriculum".

It can be understood why he felt like he is required to teach Core and Extended learners in the same class at the same time. The number of learners doing Extended Mathematics Curriculum is numbered and this makes it difficult for him to put enough effort on Extended learners since Core learners are still in the same class with Extended learners. According to CBAM, he is experiencing a personal stage of concern and is focusing on how the teaching of this curriculum affects him (Hall & Hord, 2001, as cited in Mugweni, 2012). Lastly, he indicated that time is another challenge caused by this curriculum and expressed that as follows:

"I need to spend more time to these students in trying to help them so I do not have time"

As he puts it then one can appreciate that time needs to be cautiously well thought-out so that he can be able to give learners enough time when assisting them.

In general, the results of this study showed that there are so many challenges teachers come across in the implementation of LGCSE Extended Mathematics Curriculum. Commonly, both teachers' findings revealed that there is a lack of teaching materials and teachers' development since they do not know whether they are doing what is expected. They also revealed resistance to change as a challenge to them, in view of the fact that they cannot cater for both Core and Extended learners at the same time and sometimes they become biased and focus more on gifted learners. Thus, in their lessons Core learners were part of the Extended learners' activities and used the old ways of teaching. Besides resistance, one of the challenges they both encounter is lack of materials. Among other challenges they encountered, Miss Mafa complained about workload since she has to teach Core and Extended learners in the same classroom. However, Mr Thaba emphasised that time is not enough to spend with Extended Mathematics learners.

4.4 Conclusion

This chapter presented data from the questionnaire, interviews and classroom presentations from two teachers in different schools. As a wrapping up, it presented the findings of the study concerning teachers' conceptions/understandings and challenges of LGCSE Extended Mathematics Curriculum. The next chapter focused on the presentation of the discussion and interpretation of the findings of the study.

CHAPTER FIVE

DISCUSSION OF THE FINDINGS

5.1 Introduction

This chapter presents the discussion of the findings. The purpose of the discussion is to interpret and describe the significance of the researchers' findings. The research was an attempt to find out teachers' conceptions/understandings of the Extended Mathematics Curriculum. Again, to find out challenges teachers face in the implementation of the new Extended Mathematics Curriculum. Therefore, this chapter inferred the findings of this study and research questions guided this discussion. The key findings were coupled to literature and related with theory.

In the previous chapter, I presented that due to the manner that the curriculum is put into practice in the classroom, teachers might have conceptions/understandings that may affect the teaching of the curriculum and teachers may come across challenges in implementing this new curriculum. On the basis of the findings, the curriculum developers and policy makers could reflect on teachers' concerns before and after the establishment of innovations. As a result, this might help teachers to look into Extended Mathematics Curriculum in an optimistic manner and reduce challenges teachers may come across during implementation of Extended Mathematics Curriculum.

5.2 What are teachers' conceptions/understandings of LGCSE Extended Mathematics Curriculum?

Teachers' conceptions of Extended Mathematics are of great significance as Lam et al. (2013) made clear that it is through teachers' beliefs/conceptions about education, their knowledge, understanding of policies, and everyday experiences of practice that teachers understand curricular goals and learners' learning experiences. In this study, teachers' conceptions of Extended Mathematics correlate depending on the school.

To begin with, teachers' responses revealed that they view Extended Mathematics Curriculum as a good curriculum; in terms of its benefits to learners such as, it's grading, it is meant for learners who want to follow mathematically related careers and offers learners good grades unlike COSC curriculum. Teachers maintained that Extended Mathematics provides learners with necessary skills and widen their knowledge hence enhances their self-esteem. Once

more, some subjects depend on Extended Mathematics and it is highly enhanced curriculum for these reasons that open doors for learners in other universities. The findings agreed with CBAM that all teachers are at the refocusing stage of concern where they understand that the change is considered necessary as well as why it is considered necessary (Hall & Hord, 2001, as cited in Mugweni, 2012).

In spite of that, the participants believed that Extended Mathematics Curriculum is also a high-quality curriculum since it accommodates learners with mixed abilities and various interests. Robinson et al. (2014) have the same opinion that the differentiated instruction involves knowing learners, understanding the curriculum, providing several pathways to learning, sharing accountability with learners and taking a flexible and reflective approach. Similarly, Yilmaz and Sahin (2011) data analysis showed that pre-service teachers preferred constructivist teaching views more than traditional teaching views and this correlated with their epistemological beliefs. As a result, this can influence the effectiveness of teaching and learning of Extended Mathematics positively. The results of this study are parallel with Yilmaz and Sahin (2011) because they believed that this curriculum caters for learners with varied abilities and learners are allowed to construct their own learning through teachers' guidance. According to the CBAM, teachers are experiencing a management stage of concern; teachers draw attention to the process and the responsibilities involved for the innovation. They are also trying to understand the best approach to use to implement the innovation (Hall & Hord, 2001, as cited in Mugweni, 2012).

Subsequently, teachers' responses generally highlighted that little is known about Extended Mathematics Curriculum. This implies that teachers lack understanding of the new innovation which drives teachers to implement Extended Mathematics Curriculum according to their understanding and not as expected. Bantwini and King-McKenzie, (2011) have the same opinion that lack of understanding of the new reforms as a cause intended for not yet implementing the curriculum in their classrooms, as was expected and predetermined by the policy document (2002) is accounted for the problems the teachers experienced in comprehending the way the curriculum was set and its implications. Teaching of unsuitable concepts and giving wrong exercises to Core learners during the actual teaching evidently allow one to see the way teachers interpret this new curriculum. This aligns with a non-use level of nonusers; teachers at this level have little or no knowledge about the change initiative (Hall &

Hord, 2001, as cited in Mugweni, 2012), at this point, they are making no effort to learn about the change initiative either. Therefore, having slight understanding about this curriculum may bring an unproductive implementation of Extended Mathematics Curriculum.

Additionally, teachers' responses concerning Extended Mathematics Curriculum implicated that they are unfamiliar with its structure, that is, they are not acquainted with how the concepts are organised in the new curriculum. This manifested during observations where they both involved Core learners in Extended activities. Lam et.la (2013) illustrated that teachers' practice is influenced by a web of beliefs/conceptions and perspectives about curriculum and about education in general. However, beliefs about the nature of curriculum are only one aspect of the thinking that informs decisions about what to teach. The way they handled their lessons depicted that they approach the Extended curriculum just like the previous curriculum (COSC curriculum). Teachers being unfamiliar with Extended Mathematics Curriculum imply being unfamiliar with suitable or compatible teaching approaches to utilise for comprehensive teaching and learning processes.

A further novel finding is that teachers are still are in actively involved in teaching of Extended Mathematics. Teachers still maintained that they routinely use traditional methods. This suggests that teachers view Extended Mathematics as a traditional approach curriculum verbally and practically in order to wrap the syllabus on time. The findings of Chhabra and Baveja (2012), their study strongly verified the essential need for teachers to understand the mental world of their learners and shift to learner-centred classroom processes beside commonly practiced teacher-centred ones. The results of this study are different from Chhabra and Baveja because teachers do not understand that their role is not only to give the content but also to engage learners in ways of learning so that teachers will understand the learners' ways of thinking. Generally, both teachers were not implementing the curriculum as anticipated because of the conceptions they had about how it is offered. According to CBAM teachers are experiencing a consequence stage of concern; teachers at this stage, their interests focused on the impact that the innovation will have on their learners (Hall & Hord, 2001, as cited in Mugweni, 2012).

In spite of teaching approaches, presentation of their lessons implied that they both did not reflect on learners' abilities and interests and did not even try to group learners according to their varied abilities. The Core learners were learning Extended concepts and this has an effect

on Extended learners. Extended learners retarded because focus was shifted to the rest of learners thereby denying Extended learners maximum learning opportunities. Simultaneously Core learners took much of the learning time doing content not meant for them when they could have been polishing skills on their Core content. However, in line with the ideas of Senturk and Zeybek (2019) teachers mostly had established teaching-learning conceptions. Both teachers were not flexible to use teaching methods which can accommodate learners with varied learning abilities. On the contrary, Tomlinson (2014) study, long-established that the majority of effective teachers in differentiated classrooms are more in touch with their learners and their teaching methods are flexible to go with all learners' abilities. More importantly, lessons should get learners attention at the beginning of the class and learners have a right to know why the topic was taught.

Teachers' responses also revealed that Extended Mathematics involves problem solving. This give you an idea about Extended Mathematics that is designed to offer learners an ample variety of chances to explore, discover and develop their understanding of Extended Mathematics through handy activities and working on their own to solve problems. According to the CBAM, they are experiencing a refocusing stage of concern (Hall & Hord, 2001, as cited in Mugweni, 2012) and they have some idea that problem solving works better in Extended Mathematics Curriculum. As learners build up their problem skills, they learn to rely on independent, creative thinking, which improves their senses of independence; these skills, then, prepare learners for life and future careers.

Another finding is that teachers viewed learning of Extended Mathematics as gathering of facts and rules. This implies that they both did not give learners an opportunity to learn on their own. In line with the previous studies the learning of Extended Mathematics means understanding and adopting an existing knowledge structure (Viholainen et al., 2014). The findings of this study coincide with an instrumental view in mathematics where mathematical learning is inactive reception of knowledge and the adoption of different skills, (Viholainen et al., 2014), and teaching of mathematics is content-focused, with an emphasis on performance. The teaching occurs in such a way that teachers need to cover the syllabuses on time then learners learn to sit for the examinations. Teachers are experiencing an impact stage of concern; they see the impact the change is going to have on learners (Hall & Hord, 2001, as cited in Mugweni, 2012). This is not going to help Extended learners to develop independently and

acquire skills that enable lifelong learning and independent investigative. The findings of this study agreed with (Melesse ,2015), that most of the teachers teach diversified learners in the same classroom in a form of one approach without significantly addressing learners' readiness, interests, and learning profile.

Teachers' responses also revealed that teachers feel like Extended Mathematics Curriculum and Core curriculum can be taught in separate classrooms because they do not know what to do with Core learners when introducing Extended concepts. This suggests that Core learners took part in Extended Mathematics activities and this makes Extended learners to be less competitive in learning and cannot see the importance of doing Extended Mathematics Curriculum. Teachers are experiencing a refinement stage of level of use; teachers are beginning to give additional ideas to implementing Extended Mathematics. They are beginning to vary their implementation approach with the hopes of better results (Hall & Hord, 2001, as cited in Mugweni, 2012).

Yet again, the findings of this study pointed out that Extended Mathematics Curriculum does not give the intended purpose since learners do not get better credits as expected. This aligns with CBAM; teachers are experiencing a stage of consequence level of concern, teachers' attention focused on the impact than the innovation will have on their learners (Hall & Hord, 2001, as cited in Mugweni, 2012). Extended Mathematics learners are very few in the classroom and that makes teachers to be less attentive to Extended learners. Teachers focus on the whole class and forget about the learners' individual needs. The competition among Extended Mathematics learners becomes very low. Teachers seem to be too lazy to prepare learning materials to facilitate learning as a result they teach by the book as I observed when collecting data. Teachers need to remind themselves about the importance of Extended Mathematics Curriculum to learners and acquaint with learners why a certain topic of Extended Mathematics is important in their lives. The part of rational is very essential at the beginning of a topic hence gives learners reasons behind choosing Extended Mathematics and its significance.

Last of all, teachers' responses also revealed that teachers feel like Extended Mathematics Curriculum and Core curriculum can be taught in separate classes because they do not know what to do with Core learners when introducing Extended concepts. Core learners participated in Extended Mathematics activities and this makes Extended learners to be less competitive in learning. Teachers' responses in the questionnaire revealed that Extended

Mathematics Curriculum has good intentions since it offers learners good opportunities in future and allows them to choose a better career. Robinson et al. (2014) have the same opinion that the differentiated instruction involves knowing learners, understanding the curriculum, providing several pathways to learning, sharing accountability with learners and taking a flexible and reflective approach.

5.3 What are teachers' challenges in the implementation of LGCSE Extended Mathematics Curriculum?

Teachers who participated in this study evidently came across challenges in implementing Extended Mathematics Curriculum. To begin with, the findings showed that both teachers cannot design lessons that satisfy all learners' diverse needs and interests for both Core and Extended learners, in particular Extended Mathematics learners. It is still a problem to plan well-adjusted lessons which can accommodate both Core and Extended learners. They restrict and confine learners' activities in their lesson; that is why; they become subjective and focus on gifted learners. This implies that teachers did not change their responsibilities and preparations hence teachers refuse to go along with the change. Teachers are experiencing a task stage of concern; teachers are troubled about the task itself rather than their ability (Hall & Hord, 2001, as cited in Mugweni, 2012). They focus on fast learners regardless of the slow learners. Normally, teachers have a tendency to teach the way they were taught (Mapolelo & Akinsola 2015). Hargreaves (2005) study agreed that teachers do not take action in the same manner when educational change occurs or is attempted. Teachers do not comply with the principles of the new curriculum (as cited in Bantwini and King-McKenzie, 2011). Teachers need to expose Extended Mathematics learners to appropriate approaches with the intention that they can make their teaching easier and allow learners to apply Extended Mathematics they know in new situations.

The issue of teachers' extra work is very significant when trying to implement Extended Mathematics Curriculum very well. The study also found that teachers complain about additional workload especially when it comes to the number of periods and feel like they have to prepare two lessons simultaneously since they have to focus on both Core and Extended learners. Therefore, they experience a workload and this makes them leave behind the in-depth content for Extended learners. Teachers clearly showed that they are the only mathematics teachers at their schools and have a lot of periods per week. Bantwini (2010) agreed that teachers are overloaded

in their department they are teaching. This implies that teachers might be ineffective and that teachers experience a lot of work which leads to being fully unattached to their work. This can also imply that workload can interrupt the implementation of the new Extended Mathematics Curriculum in the classroom.

One more challenge teachers faced is that teachers viewed Extended Mathematics Curriculum as a barrier itself, the way it was designed is so brought, it is not easy to cover the Extended syllabus and challenging especially its' assessment. Supported by Bantwini (2010) in South Africa, the new curriculum was viewed as a load more than a simplified and updated curriculum proposed to smooth the progress of the goals of Outcomes-Based Education (OBE). The same thing pertained in Lesotho that Extended Mathematics is viewed as an extra load in view of the fact that few learners are taking Extended Mathematics Curriculum. Teachers revealed that there are very few learners taking Extended Mathematics Curriculum therefore perceive it as extra work.

Besides extra workload, the findings of this study revealed that teachers are unable to group learners according to their learning abilities; this implied that teachers still lack skills on how to prepare and deliver Extended Mathematics content effectively while Core learners are still in class therefore teachers need workshops. This overlapped with Letsie (2019) that teachers concerned in the teaching of mathematics need to be trained to satisfactorily perfect a syllabus that accounts for differentiation in terms of learners' talents regarding the variation between Core and Extended part of LGCSE mathematics (0178). Akin to, Robison et al. (2014) findings included lack of professional development and how differentiated instruction meets the needs of all learners. According to Kyahurwa (2013), changes in education with regard to curriculum at all levels require teachers to expand their level of knowledge and skills (as cited in Mandukwini 2016). Teachers are experiencing a self-stage of level of concern**;** teachers are concerned about how the change is affecting them. More often than not, they are concerned about their ability to complete the tasks required for the change and what others will believe of their ability (Hall & Hord, 2001, as cited in Mugweni, 2012). Teachers need more workshops for equipment of skills on how to teach this Extended Mathematics Curriculum as part of the differentiated curriculum.

Additionally, the findings exposed that teachers still lack content knowledge. During the actual teaching, teachers' words did not coincide with what they wrote on the chalkboard like, they said ***sin θ, cos θ and tan θ, are trigonometric ratios.*** Morgan (2014) agreed that even

though differentiated instruction is designed to do good to every learner, it requires acquainted and well organised teachers and this can only happen if teachers keep on improving their profession. Teachers need to be allowed to keep on developing their careers. Teachers' professional development is critically important especially after some few years of teaching to help teachers with things like mathematics expressions. If teachers grow professionally, they will be able to cater for each learner despite their abilities.

The teachers did not just face teachers' development as a challenge; one more challenge is clarity about the new curriculum. That is, the findings of the study revealed that teachers have little information about Extended Mathematics Curriculum, and the underlying principles of Extended Mathematics Curriculum. This is exposed by their lessons; they showed no confidence when delivering the content and are not familiar with the structure of Extended Mathematics Curriculum and this implies that they discern little about the content knowledge of Extended Mathematics. Both lessons did not connect Extended Mathematics learners in the lessons and Extended learners did not feel bonded to the lessons. Unlike Tomlinson and Imbeau (2010); Nicolae (2013); Deringol and Davasligil (2020); Robison et al. (2014); confirmed that learners become engaged and successful in school if they are taught in an open-minded way to their readiness, interest and learning profile. Similarly, Robison et al. (2014) revealed that differentiated instruction corresponding with constructivist learning theories recommends learners the opportunity to build upon their previous knowledge while developing their own skills, interests, styles, and talents. Extended Mathematics learners need to be given a chance to prove themselves by learning on their own and build on their background knowledge. According to the CBAM, both teachers are experiencing non-use stage of level of use; at this stage, teachers have little knowledge about the new Extended Mathematics Curriculum and are making no attempt to learn about the change initiative either (Hall & Hord, 2001, as cited in Mugweni, 2012). More enlightenment is needed to help teachers to handle LGCSE Extended Mathematics Curriculum.

In addition, the findings of the study showed that teachers still cannot distinguish between Core and Extended Mathematics concepts. This reflects that teachers still have a serious problem with the structure of the new curriculum and the contents it entails. They both introduced Extended concepts in their lessons not considering Core learners. Teaching of Extended learners is a setback to schools with only one mathematics teacher since teachers

become unfair to Extended learners by focusing on straightforward content which is basic content (Core content). This implies that teachers need assistance and more information on the details of mathematics contents especially its concepts in order to plan and manage a mixed ability classroom. Teachers alleged that the workshops held when implementing the new curriculum was insufficient to declare that they had fully acquired enough information and understand what is really needed and are ready to implement Extended Mathematics Curriculum.

5.4 Conclusion

This chapter focused on the discussion and interpretation of data in responding to the research questions of this study. This study again used literature relating to teachers' conceptions/understandings of Extended Mathematics Curriculum and challenges teachers face when implementing LGCSE Extended Mathematics Curriculum. The chapter that follows discusses conclusions based on the research questions, recommendations to relevant stakeholders and recommendations for further research. It closes with some limitations of the study.

CHAPTER SIX

CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

6.1 Conclusion

This chapter concluded the study by summarising the key research findings in relation to the research aim and questions; aim:

- To investigate teachers' conceptions/understandings and challenges of LGCSE Extended Mathematics Curriculum.

Through questionnaire, teachers' interviews, and classroom observations, the following intentions were to be investigated;

- Teachers' conceptions/understandings of LGCSE Extended Mathematics Curriculum.
- Teachers' challenges in the implementation of LGCSE Extended Mathematics Curriculum.

The data was organised from themes that surfaced and analysed according to research questions. CBAM was used to analyse the data as a framework**.** The chapter also discussed the value and contribution thereof. It also reviewed the limitations and recommendations of the study, and proposed opportunities for future research.

Through the predetermined aim of this study and being conscious that teachers are the ones to implement new changes, it was very important to consider teachers' conceptions/understandings of LGCSE Extended Mathematics and challenges teachers face in the implementation of LGCSE Extended Mathematics Curriculum.

Present dispute on teachers' conceptions/understandings of Extended Mathematics and challenges teachers face in the implementation of Extended Mathematics indicated that teachers trust and appreciate that LGCSE Extended Mathematics Curriculum has good intentions; it provides students with excellent grades and tertiary opportunities.

The findings of this study suggested that teachers have partial information about LGCSE mathematics curriculum especially when it comes to its concepts. Teachers cannot make a distinction between Core and Extended concepts hence could not implement the curriculum

appropriately and effectively. Teachers need in-depth knowledge about the Extended Mathematics concepts. Teachers' understanding of Extended Mathematics Curriculum can assist learners to become familiar with the learning objectives. This way, it makes the tasks of learning purposeful and goal oriented. This consideration makes learners become motivated towards learning as they are aware of the types of behavioural changes expected as learning outcome from study of Extended Mathematics complement learning.

Furthermore, findings of this study illustrate that teachers are still using traditional approaches to teaching and learning. Teachers need to meet learners' needs, comply with the policy requirements. In new teaching approaches, learners choose what they will learn, how they will learn and assess their own learning. Teachers' conceptions take part in the formation of instructional practices characteristic of their teaching. Teachers have to allow learners to take control of their own learning, that is, learners should take a more active role in the classroom.

More findings of this study further suggest that teachers believe that the new Extended Mathematics Curriculum has not been put into practice and established appropriately**.** Teachers attended workshops but they feel that their concerns, beliefs and conceptions would have been considered through training workshops. Since the training was not enough, teachers need to be fully empowered to acquire knowledge and skills about teaching methods appropriate to use in the implementation of Extended Mathematics Curriculum. Teachers clearly need to know what Extended Mathematics Curriculum contains with the intention that they act in accordance with its requirements.

More findings point out that content knowledge of teachers is also an obstacle. Teachers' content details affect how they interpret the content goals teachers are expected to reach with learners. It affects the way teachers hear and respond to learners and the questions they (learners) ask. It affects teachers' ability to approach a mathematical idea flexibly with learners and to make topic connections. It affects teachers' ability to motivate each learner at that special moment when he or she is ready or curious. Teachers need to continue to hone their mathematics content details throughout their teaching careers. LGCSE Extended Mathematics needs teachers to understand content details and be skilful enough to implement what is required in the classroom situation.

Teachers feel that the new mathematics curriculum has added more work especially when they have to focus on both Core and Extended learners when introducing Extended concepts. An

overburdened workload influences teachers' disposition and behaviour, causing poor mental focus, decreases motivation and difficulty to focus on the tasks at hand. Teachers require fewer loads so that teaching of Extended Mathematics can be effortless and efficient.

Mathematics teachers believe that Extended Mathematics Curriculum needs more time to be implemented sufficiently, since it is an extraordinarily demanding curriculum. Talking individually to the learners and assigning tasks to them based on their interests and then assessing their progress is vital and will contribute to an overall personality growth of the learners. Curriculum is a systematic and intended packaging of competencies that is knowledge, skills and attitudes they are underpinned by values. Learners should acquire these values through organised learning experiences both in formal and informal settings through the guidance of teachers. The role of the teachers in the curriculum process is to help learners develop an engaged relationship with the content. Curriculum process provides an opportunity for teachers to be creative and put their unique stamp on the classroom experience. Hence, the reason Extended Mathematics Curriculum aimed to equip learners with problem solving skills so that they can be able to deal with life situations.

Teachers feel like they cannot cope with both mathematics Core and Extended curriculum in the same classroom; therefore, teachers need to develop professionally. Continuing education helps career-minded individuals to frequently improve their skills and become more professional. It is very important for school administrators in the field of education management to enable professional development for teachers, not only to give their learners the best learning results but also to be more effective and fulfilled throughout various other aspects of their profession. Professional development for teachers ensures teachers become more adept and well-informed who are able to create valuable and personalised lessons for learners.

This study intended to enlighten the stakeholders involved in the making of mathematics curriculum changes that they should involve teachers when making such changes. As a teacher, I have learnt that teachers do have conceptions since they are the ones responsible for implementing mathematics change into practice.

As a researcher, I have learnt that teachers are faced with many challenges in the implementation of LGCSE Extended Mathematics Curriculum. Teachers are very important in the curriculum process. The role of teachers in the curriculum process is to help learners to develop an engaged relationship with the content. Active learning increases the focus and

retention of the curriculum, resulting in an exciting learning environment. Teachers should build lessons that include simulations, case studies and activities to deliver the curriculum. This interactive approach intertwines curriculum and practical experiences that immerse learners in learning. Furthermore, teachers are the experts, when it comes to understanding the individual needs of each learner. Differentiated or adaptive instruction is critical with the intention that it ensures that each learner maximises his/her potential. This shows that the curriculum process relies on teachers to modify content delivery, as needed hence why teachers are greatly required being involved in the curriculum changes.

6.2 Emergent issues

As has been discussed, teachers do encounter challenges when implementing Extended Mathematics Curriculum. Among other challenges, the textbooks seem to be the common issue. My observation revealed that lack of full access to textbooks, as per the management order, impacts students negatively. They are allowed to use these textbooks only during mathematics lessons and after the lesson learners take them back to the store room. Another observation was that the storeroom keys are kept by the school management. If he arrives late at school like he did, teachers do not have access to the store room. We had to call and wait about ten minutes for him.

Another observation noted by the researcher was that the principals do not really get involved in the implementation of this new innovation. Teachers see this new curriculum as a burden to them. Teachers do not even try to get help from neighbouring schools since their principals concluded that teachers had attended workshops therefore, they can manage the implementation of the new curriculum. Teachers need support from their colleagues (teachers), government and especially from their principals in order to implement the new curriculum properly.

6.3 Recommendations

Since there are conceptions and challenges that were identified in this study, the researcher makes recommendations on how the implementation of the differentiated curriculum, especially the Extended, could be improved. She further makes recommendations for further research that

would inform the success of the differentiated curriculum thus increasing the number of students who will opt to take and succeed in the Extended Mathematics curriculum.

6.3.1 Recommendations for teachers

- Teachers' involvement in the implementation of the Extended Mathematics Curriculum should be highly considered. This will lead to successful implementation of the Extended Mathematics syllabus.
- Teacher training institutions should make the teaching of a differentiated curriculum part of their course outlines.

6.3.2 Recommendations for Ministry of Education and Training

- Various approaches to the learner centred method should be taught and practiced in teacher training institutions.
- The Ministry of Education and Training should provide teachers with realistic workshops when introducing new curricula.
- Monitoring should be done to check that teachers are implementing the new curriculum as planned. More mathematics teachers should be employed especially in schools where there are one mathematics teachers or where there is a shortage of staff.
- More mathematics teachers should be employed especially in schools where there are one mathematics teachers or where there is a shortage of staff.
- Teachers need frequent training after the implementation of Extended Mathematics Curriculum to acquire deeper knowledge and skills concerning the new curriculum so that they can accommodate all students according to their learning abilities.

6.3.3 Recommendations for National Curriculum Development Centre (NCDC)

- Curriculum developers to include more topics such as introduction to calculus and logarithms to the syllabus to further bridge the gap between Secondary and Tertiary levels.
- Mathematics Core and Extended should be taught separately.

6.3.4 Recommendations for further research

- A wide scale study should be undertaken by the Ministry of Education to inspect the teachers' conceptions and challenges concerning LGCSE Extended Mathematics Curriculum. This can help the ministry to reconsider the process of implementation of LGCSE Extended Mathematics Curriculum.

6.4 Limitations of the study

- The participants were reluctant to be observed after so many rearrangements with the principal. They only allowed me after engaging with the participants personally. This may have affected the results of this study.
- Teachers' conceptions/understandings and challenges cannot be achieved only by having two participants so the findings are restricted to the specific situation.

6.5 Final remark

Throughout this study I have come to understand that undertaking research is an arduous journey. However, through this journey, I gained much knowledge as I worked with this research focus. I have grown professionally, socially, emotionally and academically. As the findings revealed that teachers have different understandings/conceptions about LGCSE Extended Mathematics which led to challenges teachers face in implementing Extended Mathematics Curriculum. It is my passionate aspiration that this could be an input to further studies on teachers' conceptions/understandings and challenges teachers face in implementing Extended Mathematics Curriculum.

REFERENCES

Aguilar-Gonzalez, A., Mahoz-Catalan, M.C., & Carrillo, J. (2019). An example of conceptions between mathematics teachers. Conceptions and specialised knowledge. *EURASIA, 15*(2), 1-15.

Al Shakaili, B. (2016). Investigating teachers' actual levels of use of WhatsApp application with English foundation and credit program students at Sultan Qaboos University in Oman. *The journal of teaching English for specific and academic purposes*, 39-48.

Ambrose, D.P. (1970, November). Book Review Section. *Newsletter for Maths and Science Teachers in Lesotho, 5*(2), 15-19.

Ambrose, D.P. (1967, July). Mathematics Curriculum reform in East Africa- Report on a visit. *Newsletter for Maths and Science Teachers in Lesotho, 2*(1), 12-15.

Ambrose, D. P. (1969, March). Mathematics News. *Newsletter for Maths and Science Teachers in Lesotho, 4*(1), 17-18.

Ambrose, D.P. (1966, April). The Revolution in School Mathematics: An introduction. Newsletter for Maths and Science Teachers in Lesotho, *1*(2), 4-7.

Amirali, M., & Halai, A. (2010). Teachers' knowledge about the nature of mathematics: A survey of secondary school teachers in Karachi, Pakistan. *Bulletin of Education and Research, 32*(2), 45-61.

Ary, D., Jacobs, L.C., & Sorensen, C.K. (2010). *Introduction to Research in Education. Eighth Edition.* Wadworth: USA.

Avalos, B. (2011). Teacher professional development in Teaching Education over ten years. *Teaching and Teacher Education, 27*, 10-20.

Bantwini, B. (2010). How teachers perceive the curriculum reform: Lessons from a school district in the Easten Cape Province, South Africa. *International Journal of Educational Development, 30*, 83-90.

Bantwini, B.D., & King-McKenzie, E.L. (2011). District Officials' assumptions about teacher learning and change: Hindering Factors to curriculum reform implementation in South Africa. *International Journal of Education, 3*(1), 1-26.

Baskarada, S. (2013). Qualitative Case Study. *Joint Operations Analysis Division*, 1-27.

Beswick, K. (2012). Teachers' Beliefs about school mathematics and mathematicians' mathematics and their relationship to practice. *Educ Stud Math, 79*, 127-147.

Borderns, S.K., & Abbott, B. B. (2011). *Research Design and Methods: A process Approach, Eighth Edition.* New York.

Bryman, A. (2016). *Social Research Methods.* New York: Oxford University Press.

Breslyn, W., & McGinnis, J. R. (2011). A conception of exemplary Biology, Chemistry, Earth Science, and Physical teacher's conceptions and enactment of inquiry.

Butler, M., & Van Lowe, K. (2010). Using Differentiated Instruction in Teacher Education. *International Journal for Mathematics Teaching and Learning*, 1-10.

Campbell-Phillips, S. (2020). Education and Curriculum Reform: The impact they have on learning. *BirLE- Journal, 3*(2), 1074-1082.

Cansiz, N., & Cansiz, M. (2015). The consistency between preservice teachers' epistemological beliefs and instructional strategies. *Preservice Science teacher education*, 2066-2072.

Chhabra, M., & Baveja, B. (2012). Exploring Minds: Alternative Conceptions in Science. *Procedia-Social and Behavioral Sciences, 55*, 1069-1078.

Ciesielska, M., Bostrom, K.W., & Ohlander, M. (2018). Observational Methods. *In M, Ciesielska & D. Jamielniak. Qualitative Methodologies in Organization Studies.* (pp.1-259). London, UK: Springer Nature.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research Methods in Education.* New York: Routledge.

Coy, M. J. (2019). Research Methodologies: Increasing understanding of the world. *International Journal of Scientific and Research Publications, 9*(1), 71-77.

de Vos, A. S., Strydom, H., Fouche, C. B., & Delport, C. S. l. (2011). *Research at grass roots.* Pretoria: Van Schaik.

Deringol, Y., & Davasligil, U. (2020). The effect of Differentiated Mathematics programs of the mathematics attitude of gifted children. *Malaysian online Journal of Educational Science, 8*(1), 27-37.

Dlamini, B.N. (1968, March). The possibilities and impossibilities in the introduction of modern mathematics in our schools. *Newsletter for Maths and Science Teachers in Lesotho, 3*(1), 19-23.

Du Toit, A., & Gaotlhobogwe, M. (2017). Benchmarking the intended technology curricula of Botswana and South Africa: What can we learn? *African journal of research in Mathematics, Science and Technology Education,21*(2), 148-158.

Etikan, I., Musa, S.A., & Alkassim, R.S. (2016). Comparison Sampling of Convenience and Purposive Sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1-4.

Fouche, C.B., & Schurink, W. (2011). Qualitative Research Designs. *In R. G. Profession., A.S. de Vos, H. Strydom & C.L. Delport.* (pp. 307-327). Pretoria: Van Schaik.

Francis, D. (2014). Dispelling the notion of inconsistencies teachers' mathematics beliefs and practices: A 3-year case study. *Mathematics teacher education, 17*(2).

Frejd, C. P. (2012). Teachers' conceptions of mathematical modelling at Swedish Secondary school. *Journal of Mathematical Modelling and Application,1*(5), 17-40.

Fung, D. (2017). *A Connected Curriculum for Higher Education.* London: UCL Press.

Furinghetti., Mantos, J.M., & Menghini, M. (2013). From Mathematics and Education, to Mathematics education. In A. B. M.A. Clements, *Third International Handbook of Mathematics Education* (pp. 237-302). Dordrecht- Heidelberg- London- New York: Springer.

Genc, M., & Erbas, A.K. (2020). Secondary Mathematics teachers' conceptions of Mathematical Literacy. *International Journal for Education in Mathematics and Science, and technology(JEMST),7*(3), 222-237.

Hall, E., & Hord, S. M. (2001). *Implementing Change: Patterns, Principles and Potholes.* Boston: Allyn and Bacon.

Hall, G. E., & Hord, S.M. (1987). *Change in Schools: Facilitating the process.* New York State University of New York Press.

Hall, G. E., & Hord, S. (2006). *Implementing change: Patterns, principles, and potholes.* New York, NY: Pearson.

Hlalele., Jiyane, Z., & Radebe, S. (2020). School-based Support members' understanding of curriculum differentiation and enhancement in Rural South Africa: A narrative inquiry. *Journal of Social Science and Humanities,17*(3), 143-156.

Hosman, L., & Cvetanoska, M. (2013). Technology, teachers, and training: Combining theory with Macedonia's experience. *International Journal of Education and Development using Information and Communication Technology (IJEDICT), 9, 28*-49.

Igwenagu, C. (2016). Fundamentals of research methodology and data collection. *Research Gate,* 1-47.

Joseph, S., Thomas, M., Simonette, G., & Ramsook, L. (2013). The impact of differentiated instruction in a teacher education setting: Successes and challenges. *International Journal of Higher Education, 2*(3) 1-13.

Justine, B. (2017). Curriculum Theory and Welfare State. *Espacio, Tiempo Y Education.4*(2), 19-42.

Kalu, F.A., & Bwalya, J. C. (2017). What makes qualitative research good research? An exploratory analysis of critical elements. *International Journal of Social Science Research, 5*(2), 43-56.

Khan, M.A., & Law, L.S. (2015). An integrative approach to curriculum development in higher education in the USA: Theoretical Framework. *International Education Studies, 8* (3), 66-76.

Khoboli, B. & O'toole, J.M. (2011). The Concerns-Based Adoption Model: Teachers' participation in action research. *Systemic Practice and Action Research*.

Lam, C.C., Alviar-Martin, T., Adler, S.A., & Sim, J.Y. (2013). Curriculum integration in Singapore: Teachers' perceptions and practice. *Teaching and Teacher Education, 31,* 23-34.

Lesaoana, M. (2018). Teachers' perceptions of mathematical modelling at Swedish Upper Secondary School. *Journal of Mathematical Modelling and Aplication*, *1*(5), 17-40.

Letsie, M. (2019). The Lesotho GCSE (2013): Teachers' readiness for implementation.

LGCSE Mathematics 0178/02 Examiners report. (2015). *Maseru; Examination Council of Lesotho*.

LGCSE Mathematics 0178/02 Examiners report. (2018). *Maseru: Examination Council of Lesotho*.

LGCSE Mathematics 0178/02 Examiners report. (2019). *Maseru: Examination Council of Lesotho*.

Maharajh, L.R., Nkosi, T., & Mkhize, M.C. (2016). Teachers experiences of the implementation of the curriculum and Assessment Policy Statement (CAPS) in three Primary Schools in Kwazulu Natal. *African's Public Service Delivery and Performance Review*, 371-388.

Mandukwini, N. (2016). Challenges towards curriculum implementation in high schools in Mount Fletcher District, Eastern Cape.

Mapolelo, D.C., & Akinsola, M.K. (2015). Preparation of mathematics teachers: lessons from review of literature on Teachers knowledge, beliefs and Teachers education. *International Journal of Educational Studies, 2*(1), 1-12.

McIntosh, M.J., & Morse, J.M. (2015). Situating and constructing diversity in semi-structured interviews. *Global Qualitative Nursing Research, 2*, 1-12.

Melesse, T. (2015). Differentiated instruction: Perceptions and challenges of primary teachers. *Science and Technology and Arts Research Journal, 4*(3), 253-264.

Merriam, S.B., & Tisdell, E.J. (2016). *Qualitative Research. Fourth Edition.* United States of America: Jossey-Boss.

Mills, G. (1969, February). Development in school science. Newsletter for Maths and Science Teachers in Lesotho, *4*(1), 3-5.

Ministry of Education and Training. (2016). *LGCSE Mathematics Curriculum (0178).* National Curriculum Development Centre.

Mirian, B.M., & Zulnaidi, H. (2020). Mathematics teachers conceptions of assessment: Gender and academic qualification comparisons. *International Journal of Instruction,13*(2), 239-252.

Morgan, H. (2014). Maximizing students' success with Differentiated Learning. *The cleaning house, 87*, 34-38.

Mugweni, R. (2012). Secondary school teacher's conceptualisation and implementation of the aids action programme in Zimbabwe.

Muhtarom, N., Happy, N., Nursyalidah, F. & Casanova, A. (2019). Pre-service teachers' beliefs and knowledge about Mathematics. *Journal Pendidikan Matematika,10*(1), 101-110.

Muzvidziwa, V.N., & Seotsanyana, M. (2002). Continuity, change and growth: Lesotho's Education System ISSN: p.1524-6345.

Nicolae, M. (2013). Teachers' beliefs as the differentiated instruction starting point research basis. *Social and behavioural Science, 128*, 436-431.

Qu, S.G., & Dumay, J. (2011). The qualitative research interview. *Qualitative Research in Accounting and Management, 8(3)*, 238-264.

Rabionet, S. (2011). How I learned to design and conduct semi-structured interviews: An ongoing and continuous journey. *The Qualitative Report, 6*(2), 563-566.

Raselimo, M. (2010). Curriculum Reform in Lesotho: Exploring the interface between Environmental Education and Geography in Selected Schools, 1-365.

Raselimo, M., & Thamae, C.G. (2018). Content analysis of the LGCSE Geography and Sesotho syllabi for alignment with the Lesotho Curriculum and Assessment Policy. *South African Journal of Education, 38*, 1-10.

Raselimo, M., & Mahao. (2015). The Lesotho curriculum and assessment policy: Opportunities treats. *South African Journal of Education,35,* 1-12.

Robison, L., Maldonado, N., & Whaley, J. (2014). Perceptions about Implementation of Differentiated instructions, 1-22.

Selwyn, J. (1974, May). News from Mathematics Teachers: workcards report. *Newsletter for Maths and Science Teachers in Lesotho, 5*, 10-11.

Senturk, C., & Zeybek, G. (2019). Teaching-learning conceptions and pedagogical competence perceptions of teachers: A correlational research. *Research in Pedagogy, 9*(1), 65-80.

Shakouri, N. (2014). Qualitative Research: Incredulity toward Metanarrativeness. *Journal of Education and Human Development,3*(2), 671-680.

Taole, M. (2013). Teachers' conceptions of curriculum review process. *International Journal of Educational Science, 5*(1), 39-46.

Tomlinson, C. (2014). The differentiated classroom: Responding to the needs of all learners. *Review of Educational Research,85*.

Viholainen, A., Asikainen, M., & Hirvonenn, P.E. (2014). Mathematics Student Teachers' Epistological Beliefs about the nature of mathematics and goals of Mathematics Teaching and Learning in the beginning of their studies. *Eurasia of Mathematics, Science and Technology Education, 10(2),* 159-171.

Wanjala, M. M. S., & Simiyu, C.P., (2020). Mathematics Teachers' Conceptions about problem solving and its influence on their classroom practices in Secondary Schools in Kenya. *European Journal of Education Studies,7*(4), 217-232.

Wiest, L.R., & Lamberg, T. (Eds.). (2011). *Proceedings of the 33rd annual meeting of the North American chapter of the international group for the psychology of mathematics education.* Reno, RV: University of Nevada, Reno.

Yazan, B. (2015). Three Approaches to Case Study Methods in Education: Yin, Merriam and Stake. *The Qualitative Report, 20*(2), 34-152.

Yilmaz, H & Sahin, S. (2011). “Pre-service teachers' epistemological beliefs and conceptions of teaching". *Australian Journal of Teacher Education, 36: Iss.1, Article 6,* 73-88.

Young, M. (2014). Curriculum Theory. *Cardernos de Pesquisa, 44*(151), 1-6.

APPENDICES

APPENDIX 1 A LETTER TO THE PRINCIPAL

P.O. Box 186

Peka 340

LERIBE

Dear Sir /Madam,

PERMISSION LETTER TO CONDUCT RESEARCH

I am 'Makholu Maureen Thokoa, a Master's Student studying at the National University of Lesotho. In fulfilment of my degree, I am required to carry out a research project in my field of interest. I chose the following topic for my field of research:

Teachers' conceptions and challenges of LGCSE Extended Mathematics Curriculum.

Using teachers as participants, this research aims to answer the following research questions:

- What are teachers' conceptions/understandings of LGCSE Extended Mathematics Curriculum?
- What are teachers' challenges in implementation of LGCSE Extended Mathematics Curriculum?

The findings of this research will contribute to the knowledge of what are Extended Mathematics teachers' conceptions and challenges of LGCSE Extended Mathematics Curriculum. These findings will be of benefit to mathematics teachers, students, pre-service teachers and beginning teachers. It will also be of benefit to the schools and Department of Education.

Research Ethics:

- There will be no risks to the participants.
- The principle of voluntary participation will be adhered to and the participants may withdraw from the study at any point.

- The respondents will be offered confidentiality and anonymity by signing a confidentiality contract. Each respondent will be given a fictitious name. The respondents will not be aware of the fictitious name and the code for the various respondents.
- The respondents will receive feedback on the research process. They will also be asked to respond to transcripts of interviews to verify and confirm the responses given during the interview.
- The research data will be used for the purposes of this research only.

Research Expectations of Respondents:

- The teacher participation will be for the duration of two weeks.
- Each teacher will be expected to participate in interviews and to teach one lesson for observation purposes. Teacher resources will be examined.

Thank you for your assistance.

Researcher: ‘Makholu Maureen Thokoa

Supervisor: Dr. N. Morobe

Yours sincerely

_____

M.M. Thokoa

APPENDIX 2 A LETTER TO THE TEACHER

P.O. Box 186

Peka 340

LERIBE

Dear teacher,

PERMISSION LETTER TO CONDUCT RESEARCH

I am ‘Makholu Maureen Thokoa, a Master’s Student studying at the National University of Lesotho.

In fulfilment of my degree, I am required to conduct a research project in my field of interest. I chose the following topic for my field of research:

A case study investigating teachers’ conceptions and challenges of LGCSE Extended Mathematics Curriculum.

Using teachers as participants, this research aims to answer the following research questions:

- What are teachers’ conceptions/understandings of LGCSE Extended Mathematics Curriculum?
- What are teachers’ challenges in implementation of LGCSE Extended Mathematics Curriculum?

The findings of this research will contribute to the knowledge of what are Extended Mathematics teachers’ conceptions about LGCSE Extended Mathematics Curriculum. These findings will be of benefit to mathematics teachers, students, pre -service teachers and beginning teachers. It will also be of benefit to the school and Department of Education.

Research Ethics:

- The principle of voluntary participation will be adhered to and the participants may withdraw from the study at any point.
- The respondents will be offered confidentiality and anonymity by signing a confidentiality contract. Each respondent will be given a fictitious name. The respondents will not be aware of the fictitious name and the code for the various respondents.
- The respondents will receive feedback on the research process. They will also be asked to respond to transcripts of interviews to verify and confirm the responses given during the interview.
- The research data will be used for the purposes of this research only.

Research Expectations of Respondents:

- The teacher participation will be for the duration of two weeks.
- Each teacher will be expected to participate in interviews and to teach two lessons for observation purposes. Teacher resources will be examined.

Thank you for your assistance.

Researcher: ‘Makholu Maureen Thokoa

Supervisor: Dr. N. Morobe

Yours sincerely

_____

M.M. Thokoa

APPENDIX 3 CONSENT FORM FOR TEACHERS

I have read the above and agree with the terms. I understand that my real name will not be used in any aspect of the write-up of the study and that the information will only be used for the purposes of this research project. I am also aware that I am not obliged to answer all the questions and may feel free to withdraw from the study at any point.

I have given consent to my participation in this research.

Name: _____

Signature: _____

Date: _____

APPENDIX 4 QUESTIONNAIRE FOR MATHEMATICS TEACHERS

1. When and where did you do your teacher training?

_____
_____

2. How long have you been teaching?

_____
_____
_____

3. What challenges are involved in teaching Extended students in the same class with Core learners?

_____
_____
_____
_____
_____

4. What is your understanding of Extended Mathematics Curriculum?

_____
_____
_____
_____
_____

5. What kind of support was given to teachers during the implementation of the Extended Mathematics Curriculum?

_____

_____

_____

_____

_____

6. Explain your approach to implementation of the Extended Mathematics Curriculum in the classroom?

_____

_____

_____

_____

_____

_____

7. What are your general views/opinions on Extended Mathematics Curriculum?

_____

_____

_____

_____

_____

_____

_____

8. Do you think the Extended curriculum serves the intended purpose?

_____

_____

_____

_____

_____

9. What are the challenges you are facing when implementing Extended Mathematics in general?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

10. What are your conceptions about Extended Mathematics Curriculum?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

APPENDIX 5 OBSERVATION SHEET

NAME OF THE TEACHER _____	**NAME OF THE SCHOOL** _____	
TEACHER TALK AND ACTION	**STUDENT RESPONSES**	**OBSERVER' COMMENTS**

APPENDIX 6 INTERVIEW GUIDE

What are your views of the Extended Mathematics Curriculum?

a. What are the good aspects of the curriculum? Explain

b. Are there any challenges? Explain

c. Are there any changes you would want to see in this curriculum?