Learning to teach secondary school mathematics from practice: An exploration of the Zimbabwean pre-service teachers' year-long field experiences

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DECLARATION

I hereby declare that this thesis is a presentation of my original and genuine research work. For all the sources quoted, every effort has been made to acknowledge this, with due reference to literature. I further declare that the thesis has not been submitted in whole or in part for any other previous degree application at any university.

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MAKAMURE C   DATE

DEDICATION

My loving husband: Alex Makamure. You have been very supportive and always there for me. You have challenged me with your amazing patience, resilience, love and care.

My children: Vongai, Tinashe, Tendai and Munyaradzi. With all your patience, support and love, I am what I am today. God bless you.

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SUMMARY OF THE STUDY

Previous research in teacher education has examined teaching practice (TP) as an important part of teacher preparation. Accordingly, a number of Zimbabwean researchers have also focused on teaching practice in order to explore its influence on 'learning to teach' generally. In mathematics education, the focus on TP partly reflects the belief that 'learning to teach' mathematics without practice would be difficult, if not impossible. Despite the importance that is attached to mathematics as a subject and teaching practice as playing a pivotal role in the improvement of mathematics teaching, pre-service teachers' training has not been helpful in addressing performance deficits in secondary school mathematics. Student achievement in mathematics has remained low in Zimbabwe and across the world. In search of possible solutions to this challenge of poor performance in mathematics, the present study explored the significance and possible contribution of teaching practice to teacher knowledge and expertise which are required to improve secondary school mathematics in Zimbabwe.

A mixed methods research approach, based on a sequential explanatory design, was selected for the study. Pre-service teachers and school-based mentors answered questionnaires and focus group interviews. At the same time, college supervisors participated in semi-structured interviews on the connections between pre-service teachers' expectations and experiences of TP.

The first set of findings from the study suggests that before going on TP, pre-service teachers have positive, but perhaps exaggerated, expectations about teaching mathematics and these expectations seem to affect the way they teach in the classroom during TP. The study thus recommends that teacher education needs to address these expectations more directly prior to school placement.

The second set of findings point to the apparent discord between the mathematics content that is taught to pre-service teachers during teacher preparation and what they are expected to teach in schools during TP. A better alignment between the college mathematics curriculum and the school curriculum is suggested. This does not mean teaching the high school curriculum in college, but points to the need to align topics and/or themes between the two sets of curricula.

Thirdly, the study uncovered a disturbing imbalance between the focus on content knowledge (CK) on the one hand and the pedagogical content knowledge (PCK) and curriculum knowledge on the other. It is therefore suggested that for effective mathematics teaching during TP, the development of mathematics teachers needs to be approached in a holistic manner where content knowledge (CK), pedagogical content knowledge (PCK) and curriculum knowledge are integrated deliberately during teacher preparation.

Finally, the findings suggest that there is a difference between pre-service teachers' expectations before TP and their experiences during TP. The pre-service teachers' struggle with the transfer of learned skills into classroom practice and the variable quality of the school-based mentorship practices by supervisors explain much of the differences between the expectations and actual experiences. A review of the college syllabus to include more mathematics pedagogy is thus called for, together with a more robust training programme for school and college-based supervisors, in addition to improved incentives for school-based supervision.

In conclusion, the current study re-affirms the importance of teaching practice in teacher education in Zimbabwe, as it is in other countries. Teaching practice provides opportunities for mathematics pre-service teachers to spend time in real classrooms and 'learn to teach' from experience. However, the study has also established that teaching practice is not just about the time spent in the field, but more about the development of skills and competences for effective teaching and application of principles studied to teach and to bring about change in practice.

Keywords: learning to teach, teaching practice, pre-service teachers, mathematics knowledge, pedagogical content knowledge, pre-service teacher expectations, pedagogy.

SAMEVATTING VAN DIE STUDIE

Vorige navorsing in onderwyseropvoeding het praktiese onderwys (PO) as 'n belangrike deel van onderwysers se voorbereiding geïdentifiseer. Vervolglik het 'n aantal Zimbabwiese navorsers ook op praktiese onderwys gefokus om die algemene invloed daarvan op "leer om te onderrig" te verken. In wiskundeonderwys weerspieël die fokus op PO gedeeltelik die opvatting dat "leer om te onderrig" in wiskunde sonder praktiese oefening moeilik, indien nie onmoontlik, sou wees. Ongeag die belangrikheid wat aan wiskunde as vak en praktiese onderwys se sleutelrol in die verbetering van wiskundeonderwys geheg word, het onderwysstudente se opleiding tot dusver nie daarin geslaag om die prestasietekorte in hoërskoolwiskunde aan te spreek nie. Leerderprestasie bly laag in Zimbabwe en regoor die wêreld. In die soeke na moontlike oplossings tot hierdie uitdaging van swak prestasie in wiskunde verken die huidige studie die belangrikheid en moontlike bydrae van praktiese onderwys tot onderwyserkennis en -vaardigheid, wat nodig is om hoërskoolwiskunde in Zimbabwe te verbeter.

'n Gemengde metodes-benadering, gebaseer op 'n sekwensiële verklarende ontwerp, is vir hierdie studie gekies. Onderwysstudente en skoolgebaseerde mentors het vraelyste en fokusgroeponderhoude beantwoord. Terselfdertyd het kollegetoesighouers aan semi-gestruktureerde onderhoude oor die skakels tussen onderwysstudente se verwagtinge en ervarings van PO deelgeneem.

Die eerste stel bevindinge uit die studie suggereer dat voordat hulle PO onderneem, onderwysstudente positiewe, maar miskien oordrewe, verwagtinge oor die aanbied van wiskunde het en hierdie verwagtinge affekteer skynbaar die manier waarop hulle in die klaskamer gedurende PO klasgee. Die studie beveel dus aan dat onderwyseropvoeding hierdie verwagtinge meer direk moet aanspreek voor plasing in skole.

Die tweede stel bevindinge wys na die skynbare oneenstemmigheid tussen die wiskundige inhoud wat aan onderwysstudente gedurende onderwyseropleiding geleer word en wat van hulle verwag word om in skole gedurende PO aan te bied. 'n Beter ooreenstemming tussen die universiteitswiskundekurrikulum en die skoolkurrikulum word voorgestel. Dit beteken nie dat die hoërskoolkurrikulum op

universiteitsvlak aangebied moet word nie, maar wys na die behoefte daaraan om die onderwerpe en/of temas tussen die twee stelle kurrikula met mekaar in lyn te bring.

Derdens het die studie 'n onthutsende wanbalans tussen die fokus op inhoudkennis (IK) aan die een kant en die pedagogiese inhoudkennis (PIK) en kurrikulumkennis aan die ander kant ontbloot. Dit word dus aanbeveel dat vir effektiewe wiskundeonderrig gedurende PO, die ontwikkeling van wiskunde-onderwysers op 'n holistiese wyse benader moet word, waar inhoudkennis (IK), pedagogiese inhoudkennis (PIK) en kurrikulumkennis doelbewus gedurende onderwyseropleiding geïntegreer word.

Laastens suggereer die bevindings dat daar 'n verskil is tussen onderwysstudente se verwagtinge voor PO en hul ervarings gedurende PO. Die onderwysstudente ervaar probleme met die oordrag van aangeleerde vaardighede na klaskamerpraktyk en die veranderlike gehalte van die skoolgebaseerde mentorskapspraktyke deur toesighouers verklaar baie van die verskille tussen die verwagtinge en die werklike ervarings. 'n Hersiening van die universiteitsillabus om meer wiskundige pedagogie in te sluit, word dus gevra, tesame met 'n meer robuuste opleidingsprogram vir skool- en universiteitsgebaseerde toesighouers, asook verbeterde insentiewe vir skoolgebaseerde toesighouding.

Om af te sluit herbevestig die huidige studie die belang van praktiese onderwys in onderwyseropvoeding in Zimbabwe, soos in ander lande. Praktiese onderwys verskaf geleenthede vir onderwysstudente in wiskunde om tyd in werklike klaskamers deur te bring en om te "leer om te onderrig" uit ervaring. Die studie het egter ook vasgestel dat praktiese onderwys nie net gaan oor die tyd wat in die praktyk deurgebring word nie, maar ook oor die ontwikkeling van talente en vaardighede vir effektiewe onderwys en toepassing van die bestudeerde beginsels en om verandering in die praktyk te bewerkstellig.

Sleutelwoorde: leer om te onderrig, praktiese onderwys, onderwysstudente, wiskundekennis, pedagogiese inhoudkennis, onderwysstudente se verwagtinge, pedagogie.

CONTENTS

ACRONYMS

TP	Teaching practice
PCK	Pedagogical content knowledge
CK	Content knowledge
ZIMSEC	Zimbabwe schools Examinations Council
MKT	Mathematics knowledge for teaching
CGI	Cognitively guided instruction
MCK	mathematics content knowledge
FGI	Focus group interview
SSI	Semi-structured interview
PST	Pre-Service Teacher
f	frequency
S.D	Standard deviation
HOD	Head of department

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

APPENDIX 1: ETHICAL CLEARANCE: UNIVERSITY OF THE FREE STATE

APPENDIX 2: REQUEST LETTERS TO CONDUCT RESEARCH

APPENDIX 3: PERMISSION LETTERS

APPENDIX 4: INVITATION LETTERS TO PARTICIPATE IN THE RESEARCH

APPENDIX 5: RESEARCH INSTRUMENTS

APPENDIX 6: EDUCATIONAL DOCUMENTS REVIEWED

APPENDIX 7: STATISTICAL INFORMATION

CHAPTER 1

ORIENTATION AND BACKGROUND TO THE STUDY

1.0   Introduction

This study reports on an investigation of how field experience in teaching prepares pre-service teachers to effectively deal with the challenges and complexities of teaching mathematics in Zimbabwean secondary schools. The study was premised on the view that improvement in learning secondary school mathematics in the classroom is related to the practitioner development in teaching and that teaching develops through a learning process (Jaworski, 2006). In the same vein, Mergler and Spooner-Lane (2012) contend that pre-service teacher education is meant to produce quality teachers. The aim of the study was therefore, specifically, to explore the pre-service teachers' development of teacher knowledge. This exploration is focused on the significance and contribution of field experiences to teacher knowledge and expertise, as described by the concept of "learning to teach". In accordance with this aim, the study first established the pre-service teachers' expectations and prior beliefs regarding their own learning to teach before they went on teaching practice and then compared these prior expectations with their actual experiences and beliefs during their field experiences. Research suggests that pre-service teachers' beliefs and expectations influence their thoughts and actions, perceptions and judgement (Incecay, 2011; Lo & Anderson, 2010) hence, the need to investigate the link between pre-service teachers' beliefs and expectations and their instructional practices. Furthermore, it is essential to understand these beliefs because teachers' beliefs influence students' beliefs through instructional practices (Frydaki & Mamoura, 2011; Incecay, 2011). More so, Barahona (2014), Chalies, Escalie, Bertone and Clarke (2012) and Rahman, Scaife and Yahya (2010) assert that teacher education programmes need to use pre-service teachers' prior beliefs and preconceptions about teaching and schooling in order to reshape and direct the facilitation of pre-service teachers' learning.

The aim of teacher preparation programmes is to develop the skills and competencies of pre-service teachers during their training (Hamaidi, Al-Shara, Arouri

& Abu Awwad, 2014).These competencies include lesson planning, classroom management, teaching methods and relationships with the students and mentors, among others. Mostly, these activities take place in a classroom situation, which indicates how crucial teaching practice (TP) is to the moulding of competent teachers. Teaching practice is the most confusing and conflicting part of the teacher preparation programme and it may cause pre-service teachers stress (Wideen, Smith & Moon, 1998). Similarly, teaching is one of the most stressful professions the world over (Jusoh, 2012; Hamaidi *et al.,* 2014). Yet success of any plan to improve teacher education depends on the teachers and the manner in which they are prepared for teaching (Gan, 2013; Tatto & Senk, 2011). Focus may thus be placed on the quality of teacher preparatory programmes to ensure they positively influence pre-service teachers' "learning to teach"*.*

Diko and Feza (2014) examine the teacher education curriculum in South Africa as a window to understand how it prepares trainee teachers for their respective roles upon graduation. In the same breath, studies by van den Bos and Brouwer (2014) and Snyder (2012), show that one of the characteristics of teacher education that is capable of changing pre-service teachers is experiential learning. This implies that pre-service teachers can change their perceptions, behaviour and expectations about teaching through teaching practice experiences. Hence, according to Eisenhardt, Besnoy and Steele (2012), pre-service teachers need field experiences that create dissonance and links with their prior beliefs and expectations, so that they can provide germane assistance to their students.

Although some pre-service teachers' beliefs about the role of mathematics teachers contradict mathematics learning in the classrooms (Lo & Anderson, 2010), pre-service teachers' beliefs and expectations of teaching play a powerful role in learning to teach (Lee, 2003) and may assist or hinder pre-service teachers' own learning. Some researchers (Eisenhardt *et al.*, 2012; Lee, 2003; Nicol & Crespo, 2003; Wideen *et al.*, 1998) have noted with concern that pre-service teachers' teaching behaviours, preconceived notions and misconceptions about teaching affect their experiences of teacher education. In agreement with this idea, Barahona (2014) concurs that these preconceptions determine pre-service teachers' learning. However, he asserts that these can be shaped and reshaped during "learning to

teach" and can eventually be developed into useful concepts. Most of these pre-existing beliefs normally originate from personal experiences, schooling and cultural beliefs. According to Lo and Anderson (2010), these beliefs about learning to teach may be resistant to change. This means that pre-service teachers may be drilled with the theory of education or knowledge of how to teach and qualify to be a teacher but still hold on to the same beliefs that they held before "learning to teach". This can happen when teacher preparation programmes do not pay sufficient attention to prior beliefs and experiences during the training of pre-service teachers (Goh & Blake, 2015). Furthermore, the inadequate guidance during teaching practice may result in pre-service teachers merely coping with teaching instead of proactively teaching learners (Rahman *et al.,* 2010). Teacher preparation programmes, therefore, need to pay attention to the training of pre-service teachers before they enter the field (Rahman *et al.,* 2010). Cole and Knowles (1993) also argue that prior educational experiences are the deciding factor in the success or failure of pre-service teachers during teaching practice.

Teaching practice is a component of "learning to teach" in teacher education, which provides a transition from theory to real teaching contexts (Saban & Cocklar, 2013; Tarman, 2012). Since "learning to teach" can be defined as a cognitive and/or behavioural change process (Haser, 2010), teaching practice therefore needs to involve the changing of existing knowledge relating to teaching and learning. The aim of teaching practice therefore, according to Altintas and Gorgen (2014), is to ensure that pre-service teachers are well prepared for the teaching profession. Their ability to transfer knowledge and skills into action improves their competence in the real teaching environment. However, a study carried out by Oonk (2009) shows that some people view teaching practice as the opposite of theoretical knowledge. This indicates that teaching practice and theory are misconstrued as separate and independent bodies of knowledge. Oonk (2009) further argues that the role of theory is to provide a foundation conducive to teaching practice, that is, it grows, purifies and improves teaching practice. Hence, theory needs to be incorporated into practice if a competent teacher is to be developed.

When pre-service teachers are on teaching practice, they meet with learners for the first time and this provides them with opportunities to employ in the classroom the

knowledge, information and theory gained during their study journey (Hamaidi *et al.,* 2014; Jusoh, 2012). Teaching practice allows pre-service teachers to develop and enhance their practical abilities and activities in teaching (Hamaidi *et al.,* 2014; Wideen, 1998). Similarly, during classroom practice, pre-service teachers get insight into their weaknesses and the difficulties and problems related to their expectations about teaching. This is helpful in their future experiences in the profession. In line with the general assumption that experience is the best teacher, teaching practice has become vital in teacher preparatory programmes (Maphosa, Shumba & Shumba 2007; Perry, 2004; Quick & Sieborger, 2005) and is considered the core of learning to teach (Hamaidi *et al.,* 2014). Hence, the teacher preparatory programmes in Zimbabwe emphasise "learning to teach" through practice and therefore all potential teachers have to go through teaching practice to attain a teaching qualification.

Even though there is much information about the importance of teaching practice in assisting students to gain real classroom experience, the term "experience" has often been misconstrued. Studies by Hollins, Luna and Lopez (2014) and Scribner and Akiba (2010) reveal that the amount of time spent teaching (referred to as "experience"), is not always related to instructional quality. This shows that measuring experience in terms of the passage of time may not be suitable if it does not portray the extent of professional development. In addition, Hurrell (2013) emphasises that teaching experience and expertise are often confused. He contends that teaching experience does not equate to teaching expertise. Teaching practice, coupled with a reflection of classroom experiences and the enactment of identified changes can equate to teaching expertise (Hurrell, 2013; Kleickmann, Richter & Kunter, 2013). This coincides with the opinion that teaching experience only becomes educational if students reflect on their experiences and develop new perspectives (Sheafer, 2014). The fact that pre-service teachers spend one year on teaching practice is therefore not enough evidence that they have improved. Teacher educators therefore need to ensure that pre-service teachers are acquainted with skills to be able to teach against the grain, be effective and work to alter much of what is taken for granted. The present study thus sought to understand the contribution of the one year-long school placement to the development of expertise for teaching mathematics among groups of pre-service teachers in two Zimbabwean

secondary colleges of education.

1.1 Background of the study

Teaching practice has, historically, become an integral part of teacher training programmes the world over (Gan, 2013; Hamaidi *et al.,* 2014; Nestojko, Bui, Kornell & Bjork, 2014; Santagata, Zannoni & Stigler, 2007) and Zimbabwe is no exception to this trend. Not surprisingly, much research in teacher education thus focuses on teaching practice (TP) and asserts its importance in the development of pre-service teachers (Martin, 1998). Bennett and Turner-Bisset (1993) for example, argue that the theory and practice of teaching and "learning to teach" are inseparable. Similarly, Eisenhardt *et al.* (2012) and Hamaidi *et al.* (2014) also contend that theory without practice and practice without theory are futile. Van den Bos and Brouwer (2014) concur with this view when they posit that "learning to teach" has to be considered as interaction between conceptions and practice of pre-service teachers. This view reflects the belief that "learning to teach" without practice is assumed to be impossible. Consistent with this idea, Santagata *et al.* (2007) demonstrate how the National Commission on Teaching and America's Future (NCTAF) (1996), the National Commission on Excellence in Education (1983) and other influential bodies in the USA have consistently drawn attention to the important contribution that teaching practice makes in preparing pre-service teachers to handle the complexity and challenges of the school and classroom contexts.

Precisely because of the assumed importance of teaching practice in the education of prospective teachers, as well as the less than positive reviews by pre-service teachers and observers, the government of Zimbabwe has, in recent years, reprioritised teaching practice. This was especially done in the teaching of mathematics, science and technology (STEM) as the gaze on this aspect of teacher education was increased (National Report of Zimbabwe, 2004). The sharpened attention on "learning to teach" secondary school mathematics has also come with somewhat increased funding allocations and support (Southern African Regional Universities Association [SARUA], 2009). For instance, the Zimbabwe Manpower Development Fund (ZIMDEF) fully embraced the transformation of the national education system through deepening STEM, commonly known as *"stematising".*

Through the Ministry of Higher and Tertiary Education, ZIMDEF mobilised financial resources for skilled human capital development. To date, however, there has been no large-scale study of "learning to teach" secondary school mathematics in Zimbabwe to either justify the increased focus and/or the funding. The present study sought to provide insights regarding the contribution of teaching practice to the prospective mathematics teachers' "learning to teach", in part because of the consistently disappointing mathematics results at "O" level in Zimbabwe (Kusure & Basira, 2012, ZIMSEC Results Analysis, 2015). With reference to the poor performance in "O" level examinations in 2011 and 2012 (Majongwe, 2013) in Zimbabwe, Mukeredzi (2013) explains that poorly educated teachers produce poorly educated students. Consequently, special attention needs to be given to pre-service teachers' teaching practice training to enhance learners' achievements.

As pointed out by Zeichner and Liston (1987) many years ago, learning from field experiences is far from being unproblematic. Similarly, Richardson-Koehler (1987) makes the point that the problems faced by pre-service teachers, mentors and college supervisors tended to obscure the reality of the practice of teaching. These research findings on the challenges of teaching practice are echoed by Cole and Knowles (1993) and Ferman-Nemser & Buchmann (1983), who note that there appears to be a mismatch between pre-service teachers' college learning and their expectations in the field. Cole and Knowles (1993) contend that many pre-service teachers' optimistic views of teaching practice are often shattered when their experiences of teaching practice are less than positive. This may suggest that the theoretical knowledge that students acquire in college might not imbue them with the ability to implement this knowledge.

Furthermore, content knowledge and certification are also crucial to effective teaching practice. In their study, Bennett and Turner-Bisset (1993) note that pre-service teachers with higher levels of content knowledge (CK) proved to be better teachers than their counterparts with less CK. Tatto and Senk (2011) agree that pre-service teachers require a deep understanding of the content they will teach for their teaching to be effective. In this regard, pre-service teachers' credentials, as indicators of teacher knowledge, are considered crucial. The NCTAF (1996), as cited in Ball, Lubienski and Mewborn (2001), provides compelling evidence that teachers

need to know the content well in order to be able to make concepts comprehensible to learners.

Based on several studies, the report produced by the NCTAF has shown that discrepancies in teacher qualifications accounted for more than 90% of the variation in student achievement in mathematics even though the researchers did not consider the quality and nature of degrees attained. However, Ball, Hill and Bass (2005) stand to differ as they proffer that the volume and complexity of knowledge that the teacher has does not assist in untangling the learners' challenges and they rather emphasise teacher knowledge, specifically the question of what to teach and how to teach it. In line with this, Tatto and Senk (2011) argue that, if they are to be successful, mathematics teachers need to be acquainted with the knowledge of mathematics, how students learn mathematics and mathematical pedagogy. Shulman (1986), in support of this assessment, discusses the amalgam of content and pedagogy (which he calls "pedagogical content knowledge") that is needed to promote effective teaching. This suggests that, without pedagogical content knowledge (PCK), the demarcation between a teacher and a subject specialist becomes blurred. The overriding point here is that an understanding of the subject matter (or knowledge thereof), is void of any importance to a mathematics teacher if it cannot be communicated to the learners. Hence, PCK embraces more than what is taught in mathematics courses in teachers' colleges.

In the opinion of Mosvold and Fauskanger (2014), the debate on which aspect of teacher knowledge is more important than the other, is not beneficial, even though research on a specific component is still relevant. Similarly, Diko and Feza (2014) suggest that emphasising one component of teacher knowledge at the expense of another is risky. It is not only theoretical knowledge that determines successful teaching but transformation of concepts through meaningful practicum as well (Frydaki & Mamoura, 2011; Hamaidi *et al.,* 2014). Hence, Shulman (1986) emphasises the balance between content knowledge and pedagogical content knowledge during learning to teach. However, teachers need certain levels of ability in order to be able to teach learners from diverse backgrounds (Darling-Hammond, 2006). This suggests the need for intertwining teacher training components for effectiveness (Diko & Feza, 2014).

While researchers acknowledge that much research has been done on teachers' mathematical knowledge, they have doubts whether this has achieved the purpose of gaining students' mathematics achievement (Ball *et al.*, 2001). Carter (1990) asserts that research on teacher knowledge has largely been unproductive. This is partly because, regardless of the overwhelming research on pre-service teachers' mathematical knowledge, the problem of poor achievement in mathematics continues unabated (Ball *et al.,* 2005). The present study thus sought to contribute insights on the same issue of pre-service teachers' knowledge of mathematics by examining one aspect of the education of prospective mathematics teachers, viz. the field-based experiences or what is commonly referred to as "teaching practice". Field experiences, as the basis of teacher training, is considered the blind spot in educational research because it has not found a place in the discussion and research on the components of pre-service teachers' knowledge (Oonk, 2009). As there is no agreement on the place and significance of field experiences in the development of teacher knowledge (Kim, Ham & Paine, 2011; Schmidt & Maier*,* 2009), this study has explored the significance and contribution of field experiences to teacher knowledge and expertise in mathematics, as described by the concept of "learning to teach".

1.2   Significance of the study

My personal desire to undertake this study arises from the fact that mathematics and the teaching of mathematics have always been held high in education. Furthermore, they are inescapably important in such a way that they have become the centre of conversations in every institution of learning and every society. For example, Agyei and Voogt (2010) assert that mathematics has been made compulsory in Ghana and the government has attempted to improve the achievement of the subject in schools because of its importance. Despite this, student achievement in this subject has remained low across the world. Goh and Blake (2015) aptly assert that students' achievement is measured by teacher quality; hence, the root cause of poor performance in mathematics can be traced back to the teacher. It is in this respect that in Australia, the purpose of the Common Wealth government was to increase the quality of teaching in order to beef up the effectiveness of schooling and spruce up students' learning outcomes (Mergler & Spoone-Lane, 2012). As Hurrell (2013)

posits, effective teaching is necessary for effective learning.

Teaching practice, from my point of view, is the most influential factor of students' success because it integrates theory and practice, as described by Santagata *et al.* (2007). However, after realising that pre-service teachers' training has not been helpful in addressing performance deficits in secondary school mathematics (Ball, Thames & Phelps, 2008), my passion as a mathematics lecturer was therefore, to find out what exactly is needed to become an effective mathematics teacher. My desire was to find out how we, as mathematics educators, can better assist mathematics pre-service teachers in their preparation for field experiences and the realities of teaching (Cole & Knowles, 1992). Ultimately, it seemed crucial to explore what kind of mathematics knowledge for pre-service teachers is critical for students' success. My focus was centred on the field experiences of pre-service teachers because it is where most of the pitfalls of teaching occur during the process of "learning to teach". Once pre-service teachers are in the field, they come to premature conclusions that everything about teaching has been mastered (Feiman-Nemser & Buchmann, 1983).

From my experience as a mathematics lecturer for the past twelve years, the performance of mathematics pre-service teachers during teaching practice has been weak, hence, the decision and determination to explore the significance and contribution of teaching practice to mathematics teacher knowledge in order to improve their knowledge, classroom practices and learner achievement. The purpose of the study is therefore to investigate pre-service teachers' experiences and understandings of mathematics teaching. This study is set to explore "learning to teach" through practice. "Learning to teach", according to van den Bos and Brouwer (2014) and Rahman *et al.* (2010), is an ongoing and lifelong process that is considered a product of the interplay between beliefs and practices.

Since the study is underpinned by the concept of "learning to teach", it is crucial as the study of "learning to teach" clarifies and clears pre-service teachers' misconceptions and specifies the role of teacher education programmes in training competent teachers (Feiman-Nemser & Buchmann,1983). During the process of "learning to teach", pre-service teachers' notions about teaching are normally

replaced by the practical knowledge of the subject matter, contexts and pedagogy (Rahman *et al.*, 2010). This is in line with the idea that practicum experience promotes a gradual translation from a somewhat abstract level into a teaching behaviour (van den Bos & Brouwer, 2014). The study, therefore, focuses on how pre-service teachers develop their mathematical knowledge of teaching through practice during the process of "learning to teach". An understanding of how the process of "learning to teach" develops will enable educators to examine the way pre-service teachers construct their knowledge of teaching based on what they already know, believe and how they think of themselves as teachers (Rahman *et al.*, 2010). It then implies that knowledge of "learning to teach" can create an opportunity for teacher education curriculum developers to design new curricula that are personally relevant to pre-service teachers' needs.

"Learning to teach" does not need to be perceived in parts, that is, considering different kinds of teacher knowledge (such as CK and PCK) as distinct entities which work in isolation (Rozenszajn & Yarden, 2014). Teaching practice is therefore not the be-all-end-all of "learning to teach". Without marginalising other components of teacher knowledge, this study, therefore focuses on how these various kinds of teacher knowledge contribute to the effectiveness of teaching practice.

Rahman *et al.* (2010) note four developmental stages that pre-service teachers go through as they learn to teach, viz. pre-teaching concerns, early survival concerns, teaching situation concerns and students' concerns. This view is compatible with this study because if pre-service teachers' stages of performance are clearly spelt out, it enables teacher educators to provide suitable assistance for pre-service teachers' specific needs. After disseminating copies of the dissertation to responsible authorities and accessing some copies from the internet, the results of this study may therefore help to develop awareness among teacher educators of the preconceptions, misconceptions or conceptions that they may have about field experiences and how these affect pre-service teachers' performance during teaching practice.

Since the research is aimed at exploring the expectations, dispositions and experiences of mathematics pre-service teachers before and during teaching

practice, I believe the study is likely to set the stage for teacher educators and policymakers to develop the teacher education curriculum in ways that pre-service teachers are better able to attain the knowledge, skills and dispositions required to meet the demands of the process of "learning to teach". Teacher educators will also develop an awareness of how pre-service teachers' attitudes and beliefs about teaching grow and evolve. This will focus their attention onto the practice of teaching, otherwise the use and application of study materials alone may not be adequate to improve achievement (Oonk, 2009). This will also allow teacher educators to generate strategies on how best they can assist pre-service teachers to prepare for field experiences, thereby leading to improved learner achievement.

The main concern when studying teacher knowledge is to improve teacher competence in order to enhance student achievement (Gleason, 2010). Lipton and Wellman (2014) assert that the quality of the teacher mostly determines the variation in students' learning achievements and that quality teaching matters for successful student learning. This study is important because it considered the expectations, beliefs and experiences of pre-service teachers who are directly affected by teaching practice quality and the nature of guidance that will improve their teaching. The study seeks to conscientise the authorities of the importance of field experiences so that maximum support for pre-service teachers on teaching practice is made a priority in order to promote quality education.

Currently, the consistently disappointing "O" level mathematics results in Zimbabwe, as evidenced by the ZIMSEC examination analysis (2015) is enough evidence that quality teaching is thinly spread in the country and students are poorly served in many schools. Poor quality teaching normally emanates from teacher preparatory courses that are loosely coupled to actual expectations and practices of pre-service teachers and teacher educators (Kim *et al.*, 2011; Scribner & Akiba, 2010). The importance of the study points to the exploration of the significance of field experiences to teacher knowledge and expertise in teaching secondary school mathematics in order to improve teacher effectiveness, which has a direct link to student learning (Lipton & Wellman, 2014). In this regard, the study aims to promote opportunities among pre-service teachers to grow professionally through practice.

Lipton and Wellman (2014) contend that the only way to ensure the effective learning of students with different backgrounds, learning styles and experiences, is to have teachers who are well equipped with the skills of teaching content well and who have the ability to teach diverse learners. The results of the study will therefore draw attention to the strategies that pre-service teachers on teaching practice require to enhance student achievement.

One of the objectives of this study was to investigate the mathematics and mathematics teaching that pre-service teachers on teaching practice reportedly learn. This typified the mathematics teacher knowledge that pre-service teachers need to gain and the manner in which it can be utilised on practicum experiences. The study thus sought to establish what and how mathematics pre-service teachers learn to teach secondary school mathematics effectively during teaching practice.

Research on "learning to teach" secondary school mathematics from practice has been conducted in the context of developed countries. However, more work is required particularly in the Zimbabwean context because pre-service teachers in the country have significantly different cultural environments and exposures to the rest of the developed countries. Research on the contribution of teaching practice to mathematics teacher knowledge is limited in Zimbabwe. This provided the rationale for conducting the study on the exploration of the contribution of teaching practice to mathematics pre-service teacher knowledge and practice in Zimbabwe.

1.3   Research questions

1.3.1 Main research question

The main research question for this study is:

What is the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe?

For this purpose, the following sub-questions were addressed:

a)   What are the expectations of "learning to teach" by pre-service teachers at two Zimbabwean colleges of education prior to going on teaching practice?

b) What do pre-service teachers reportedly learn about mathematics during teaching practice?

c) What do pre-service teachers reportedly learn about mathematics teaching during teaching practice?

d) How do pre-service teachers reportedly learn about mathematics and mathematics teaching during teaching practice, that is, what structures, resources and tools are employed during the "learning to teach" process?

e) What are the differences between pre-service teachers' expectations and what they reportedly learn during teaching practice?

f) How can pre-service teachers' experiences of "learning to teach" from teaching practice and their expectations be explained?

g) What suggestions and recommendations can be made to improve the experiences of "learning to teach" for mathematics pre-service teachers?

1.3.2 Aims of the research

The study sought to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe.

1.3.3 Research objectives

The study has addressed the following objectives:

a) To identify the expectations of "learning to teach" by pre-service teachers at two Zimbabwean colleges of education prior to their teaching practice.

b) To establish what pre-service teachers reportedly learn about mathematics during teaching practice.

c) To describe what pre-service teachers reportedly learn about mathematics teaching during teaching practice.

d) To explore the way pre-service teachers learn about mathematics and mathematics teaching during teaching practice, by assessing the structures, resources and tools employed during the "learning to teach" process.

e) To distinguish between the pre-service teachers' expectations and what they reportedly learn during teaching practice.

f) To assess the pre-service teachers' experiences of "learning to teach" from

teaching practice and their expectations thereof.

g) To make suggestions and recommendations on how the experiences of "learning to teach" for the mathematics pre-service teachers can be improved.

1.4   Conceptual framework

The proposed investigation was informed by the concept of "learning to teach". As defined by Sheafer (2014), "learning to teach" is a service activity that guides pre-service teachers' learning and is viewed as the transition from being a student to a teacher (Fox & Wilson, 2015; Haser, 2010; De Neve, Devos & Tuytens 2015; Tarman, 2012). Furthermore, the concept of learning to teach refers to the entire activity of teacher education (Rahman *et al.,* 2010). This indicates that "learning to teach" is a continuous process that starts well before formal teacher education, for instance, from the school experiences and can even continue after formal teacher education (van den Bos & Brouwer, 2014). Even though some researchers view "learning to teach" as the provision of knowledge of teaching to pre-service teachers, Rahman *et al.* (2010) believe that "learning to teach" is understanding what pre-service teachers believe they can do (expectations) and what they can actually do (experiences). From these beliefs, knowledge is constructed. In this study, "learning to teach" is used interchangeably with pre-service teacher learning.

Carter (1990), Lee (2003) and Wideen *et al.* (1998) view "learning to teach" as a process of acquiring knowledge about teaching and a devotion to acquiring formal knowledge and then applying it in the field. In the process of "learning to teach", the college provides the theory, knowledge and skills to the pre-service teacher, the school provides the field setting where knowledge is applied and practised and the pre-service teacher marries them all (Lee, 2003). The college campus experiences and the field experiences, thus, provide an ideal setting for "learning to teach".

Nicol and Crespo (2003) contend that some pre-service teachers' prior experiences and beliefs affect their own experiences in teacher education. Whilst some of the pre-service teachers' beliefs are accurate, most of them are myths (Eisenhardt *et al.,* 2012). Before going on teaching practice, Wideen *et al.* (1998) claim that pre-service teachers expect teaching to be simple and that everything about it will be favourable. Contrary to their expectations, pre-service teachers normally find themselves

experiencing frustration, anger and bewilderment due to factors that arise from school and classroom contexts and they blame this on the training college (Haser, 2010; Wideen *et al.*, 1998). Normally, when their beliefs conflict with what they were taught and their expectations do not conform to reality, these personal experiences and beliefs are likely to trump book knowledge (Eisenhardt *et al.,* 2012). When they realise that their beliefs are dysfunctional, their hopes and dreams may be shattered.

Pre-service teachers' beliefs are difficult, if not impossible, to change (Lee, 2003; Wideen *et al.*, 1998). Pre-service teachers therefore need to deal with their prior beliefs about teaching from universities, schools and society (Wideen *et al.*, 1998). The assumption is that the change of these beliefs, expectations and misconceptions will prompt a change in the practicum.

The concept of "learning to teach", therefore, provided this study with the opportunity to explore the pre-service teachers' college campus and field experiences, their expectations before teaching practice and how these affect their "learning to teach" secondary school mathematics. In line with the concept of "learning to teach", the study also sought to distinguish between pre-service teachers' expectations and their experiences during teaching practice and suggest ways in which the conflicts that may arise can be resolved. The purpose of the study was to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. In addition to the concept of "learning to teach", the study was also informed by the theoretical framework of "mathematical knowledge for teaching" (MKT), which is an improvement on Shulman's theoretical discussion of what knowledge is required by teachers in order to teach well (Ball *et al.*, 2008). MKT therefore represents one specific component in the "learning to teach" model, viz. the knowledge component. Teaching practice largely contributes the skills component and the synthesis between knowledge and practice. A detailed discussion of the conceptual framework that emerges from the "learning to teach" and MKT ideas is discussed in chapter 2 of the thesis.

1.5 Research design and research methodology

The research was conducted using the mixed methods approach. Creswell, Fetter and Curry (2013) define the mixed methods approach as a research design where the collected data are analysed and integrated using quantitative and qualitative approaches. Mixed methods research is a product of the pragmatist paradigm (Tashakkori & Teddlie, 2009).

The mixed methods approach was based on the explanatory sequential design. In this method, data collection is done using questionnaires first followed by interviews (Creswell *et al.*, 2013). This design depicts the events, beliefs, attitudes or policies that shape the process of "learning to teach" (Marshall & Rossman, 2011). This design was deemed appropriate for this study because, after exploring the results of data collected in quantitative form, data can be clarified, adjusted or replenished through qualitative approaches to ensure the credibility and trustworthiness of the data (Terrell, 2012).

One hundred and twenty mathematics pre-service teachers in their first year answered questionnaires prior to teaching practice to determine their expectations of mathematics, mathematics teaching and learners. Follow up questionnaires were administered to the same group of students towards the middle of teaching practice so that they provide answers on whether pre-service teachers' expectations matched their experiences during teaching practice. The third questionnaire was meant for the mentors to gather information on their experiences with pre-service teachers on teaching practice. Focus group interviews were conducted with 22 pre-service teachers on teaching practice and 14 school-based mentors. Individualised semi-structured interviews with 7 college-based lecturers were also conducted. Analysis of study materials used by pre-service teachers was done to provide additional data on what pre-service teachers learn as part of the programme.

Purposive sampling was designed to understand participants' experiences. The researcher therefore made a conscious decision regarding which pre-service teachers, mentors and colleges would best provide the desired information (Burns & Grove, 2007; De Vaus, 2002).

Data from the questionnaires were analysed using the SPSS program. Correlation coefficients, the Chi-Square test, factor analysis and descriptive statistics were used to analyse the quantitative data. Open-ended questions have been grouped into related categories and are explained. Qualitative data from interviews were comprehensively presented, interpreted and explained. A detailed report on the research methodology is elaborated on in chapter 3.

1.6 Ethical considerations

The research has been conducted with ethical approval from the University of The Free State, the Ministry of Higher and Tertiary Education, Science and Technology Development in Zimbabwe and other relevant authorities. These respective authorities meticulously examined the research activities for ethical soundness, taking into consideration issues of confidentiality, risk management, informed consent and others, prior to the collection of data from participants (Resnik, 2011). The researcher needed to maintain research integrity by avoiding plagiarism, fabrication and falsification of information. More information on ethical considerations is explained in chapter 3.

1.7   Delimitations

The study focused on one group of mathematics pre-service teachers in their first year prior to teaching practice and then during teaching practice. These pre-service teachers were from the two secondary teachers' training colleges in Zimbabwe. The sampled first year pre-service teachers answered questionnaires regarding their beliefs and expectations about teaching before going on teaching practice. During their time on teaching practice, they answered questionnaires and a smaller sample from the same group was interviewed to ascertain their experiences on the ground in relation to their expectations and beliefs. Data collection during teaching practice was done to obtain information on how the theoretical mathematics teacher knowledge taught on a college campus resonated with them during teaching practice.

1.8   Limitations

The interviews and questionnaires were limited to only 120 mathematics pre-service

teachers because of time constraints. However, the researcher sampled a true representative of the target population in order to manage the research process and maintain the validity and reliability of the findings.

The participants of the study were mostly from urban areas and a few were from rural areas close to town. This sample made it difficult to generalise the results to all pre-service teachers because the background and environment affect beliefs and expectations (Eisenhardt *et al.,* 2012; Nicol & Crespo, 2003). In order to downplay the significance of this limitation, the researcher was careful in the way she selected the subjects of the study so that nearly all backgrounds were represented.

The teachers' colleges are situated far apart and the researcher needed time and financial resources to be based in the field where data were collected. Financial constraints limited the time in the field for the researcher and some interviews were conducted over the phone. Some copies of questionnaire 2 were not returned. A rigorous follow up had to be put in place to ensure at least a 90% return. However, 87.5% ($\frac{105}{120}$) of the questionnaires were returned, of which this is within an acceptable range. Despite the large numbers of pre-service teachers involved in the study, the researcher collected most of the data on her own and was assisted in conducting some focus group interviews with pre-service teachers beyond her reach, by a lecturer from college 'b'. The researcher discussed the questions with the lecturer first before engagement. The participants' responses were audio recorded by the lecturer but transcribed by the researcher. The process was cumbersome and might have compromised the quality of results. However, the researcher tried her best to use her expertise and training to collect the data to cater for this limitation.

1.9   Layout of chapters

The structure of the thesis is as follows:

Chapter 1

The purpose of the chapter is to introduce the reader to the study and establish the basic purpose and processes of the study. Chapter 1 is the engine that drives the entire thesis because what is proposed in this chapter has to be adhered to throughout the thesis (Childers-Hon, 2008). This chapter contains the introduction,

background to the study, value of the research, research questions, aims and objectives, limitations, delimitations, an overview of the research design and theoretical considerations of the study.

In this part of the thesis, a summary of unresolved issues, conflicting findings and other concerns are also discussed (Childers-Hon, 2008). The chapter thus gives a summary of the role, significance and contribution of teaching practice to teacher knowledge during "learning to teach" as it is related to literature in the topic under review. Pre-service teachers' expectations, beliefs, experiences and perspectives are reviewed in this chapter to establish how these influenced teaching.

Chapter 2

This chapter depicts a comprehensive analysis of literature in relation to the study under review. A conceptual analysis of the concept of "learning to teach" was given. In this regard, literature on teacher knowledge for mathematics pre-service teachers was reviewed. This includes what pre-service teachers reportedly learn about mathematics and mathematics teaching. Pre-service teachers' expectations, beliefs, experiences and development of teacher knowledge during teaching practice are also explained in this chapter.

Chapter 3

This chapter involves the methodological approach to be used in the research. It presents a detailed design of the study and describes and justifies data used in the thesis. The purpose of this chapter is to describe approaches to data collection, the research paradigm, research design, target population, sampling methods, sampling procedures, research instruments, data analysis procedures and methods of ensuring the validity and reliability of the collected data. This includes the justification of choosing these approaches in relation to the research objectives. It also depicts the details of variables to be tested and procedures used to collect data. In this study, pre-service teachers' expectations and beliefs before teaching practice, experiences during teaching practice and theoretical mathematics teacher knowledge that has been learnt have been tested.

Chapter 4

Data collection, presentation, interpretation and analysis take precedence in this

chapter. Tables, graphs and figures have been used to summarise numeric and text information.

Chapter 5

This chapter gives the summary of the research, describes findings and suggests recommendations on the findings of the study. This chapter discusses the meaning of what was found in relation to the theoretical knowledge on the topic (Childers-Hon, 2008).

1.10 Summary of the chapter

The chapter begins by introducing the reader to the study and the focus of the research. In this chapter, the purpose of the study is clearly explained. The chapter describes some insights into the role of "learning to teach" mathematics through practice in teacher preparation programmes and the position and contribution of teaching practice to mathematics teacher knowledge. The conceptual framework is also presented in this chapter together with an overview of the research methodology of the study and ethical considerations during field research. The provision of the delimitations, limitations, layout of the thesis chapters and chapter summary marks the conclusion of the chapter. Next is chapter 2, which reviews literature related to the current study.

CHAPTER 2

LITERATURE REVIEW

2.0   Introduction

The main role of this chapter is to review the literature in relation to the current study. The study intends to understand the reality of the practicum in relation to pre-service teachers' perspectives and experiences. In this chapter, I reflect on the conceptual framework of "learning to teach" that guides my study with reference to content knowledge and pedagogical content knowledge by Shulman (1986) as well as mathematics knowledge for teaching by Ball *et al.* (2005) and field experiences. This is followed by an analysis of the pre-service teachers' pre-existing beliefs and expectations about teaching, their experiences in the field and the mathematics that they learn and how they learn it during field practice. The study aims to establish the significance and contribution of teaching practice to teacher knowledge and expertise as described by the concept of "learning to teach" for secondary school mathematics in Zimbabwe.

2.1   Conceptual framework

The conceptual underpinnings of this study revolve around the notion of "learning to teach". Shulman (1986) references content knowledge, curriculum knowledge and pedagogical content knowledge while Ball *et al.* (2001) reference mathematics knowledge for teaching; these provide a conceptual framework for "learning to teach" mathematics. According to Rahman *et al.* (2010), "learning to teach" refers to the entire activity of teacher education. It can also refer to teacher learning or teacher development. "Learning to teach" involves the translation of existing knowledge relating to teaching and learning (Rahman *et al.*, 2010). However, Rahman *et al.* (2010) assert that even though research on teacher knowledge is critical, the challenge is that it is difficult to understand how pre-service teachers who enter teacher preparation programmes with different backgrounds (beliefs, experiences and expectations), develop their knowledge. Knowledge transformation, therefore, becomes difficult to measure since pre-service teachers are starting from different levels of learning. These factors influence the way they teach, hence Hollins *et al.* (2014) assert that there are very few studies on "learning to teach" because there

are few people who understand it.

"Learning to teach", as defined by Sheafer (2014), is a service activity that guides pre-service teachers' learning and is viewed as the transition from being a student to being a teacher (Fox & Wilson, 2015; Haser, 2010; Lee, 2003; De Neve *et al.*, 2015). Wideen *et al.* (1998) and Lee (2003) view "learning to teach" as a process of acquiring formal knowledge about teaching and then applying it in the field. In the process of "learning to teach", the college provides theory, knowledge and skills to the pre-service teacher, the school provides the field setting where knowledge is applied and practised and the pre-service teacher marries them all (Lee, 2003). The campus and field experiences thus provide an ideal setting for "learning to teach".

Rahman *et al.* (2010) note three developmental stages in "learning to teach". The first is the novice stage in which errors are common among pre-service teachers. The second is the intermediate stage in which knowledge is developed. In the third stage, which is the advanced stage, proficiency occurs. An understanding of these stages can assist teacher educators to provide suitable assistance for pre-service teachers' specific needs or concerns.

According to Jusoh (2012) and Wideen *et al.* (1998), "learning to teach" is complex because there are many unpredictable or unknown factors during this period. In addition, teaching practice is confusing, conflicting and causes more stress than any other part of teacher preparation programmes. This is consistent with the view by Muir, Allen, Rayner & Clelan (2013) that the integration of theory and practice is normally problematic. They contend that the area where pre-service teachers' predispositions remain intractable during teaching practice is behaviour management. Most pre-service teachers rely on their experiences and what they were taught and accepted as true, with very little consideration for new knowledge. This means that teacher educators need to sharpen their focus on equipping pre-service teachers with skills on behaviour management in the classroom.

However, several research studies have advised that more attention be paid to the challenges and concerns of field practices. Jusoh (2012) asserts that a failure to address these concerns may aggravate problems for the already sophisticated teacher training programmes. To this end, Clinician and Clinician (2009), Goh and

Matthews (2011) and Rahman *et al.* (2010) used a model by Fuller and Brown (1975) to identify four developmental concerns that pre-service teachers undergo as they learn to teach. They are pre-teaching concerns, early survival concerns, teaching situation concerns and students' concerns.

Liu and Huang (2005) define teaching concerns as the perceptions, motivations, attitudes and feelings that teachers experience in relation to implementing a concept. In the teacher training programmes, pre-service teachers' concerns should be appropriately addressed to prepare them for the actual teaching environment (Cakmak, 2008). In a study conducted by Kagan (1992), pre-service teachers expressed high levels of self-concern regarding their ability to be successful in the classroom. This justifies the need to address these concerns before teaching practice takes place. Murray-Harvey *et al.* (2000) believe that identifying pre-service teachers' sources of stress is based on the fact that stress affects teacher behaviour in the classroom. By identifying pre-service teachers' concerns during teaching practice, teacher educators can determine instructional content to be selected, designed and sequenced in the teaching practice coursework based on their needs. The four types of concerns mentioned above are explained below.

(i)   Pre-teaching concerns
At the pre-teaching stage, pre-service teachers identify with the students rather than with the teachers (Kagan, 1992). According to Fuller and Brown's model (Clinician and Clinician, 2009), pre-service teachers focus their concerns on the students rather than the teacher's role. Pre-service teachers therefore perceive themselves and the students as learners. Hence, they are able to feel and understand what the students undergo.

(ii)   Survival concerns
At this stage, the pre-service teachers are concerned about their own survival needs as teachers. The pre-service teachers are concerned with whether they can survive the daily challenges of carrying the responsibility of the growth, development and learning of an entire group of students. The difference between the expected successes before teaching practice and the reality of the classroom may aggravate feelings of unpreparedness. Thus, Kagan (1992) posits that pre-service teachers at

this level have concerns regarding their ability to develop appropriate instructional material, their ability to work with students and their mastery of content. This means that pre-service teachers at this stage strive to develop survival skills to fulfil their roles as teachers in order to please their supervisors. To this end, they need specific suggestions from their mentors to meet the needs of the students. During this stage, Katz (1995) contends that pre-service teachers need support, encouragement, reassurance, comfort and guidance from their mentors and college-based teacher educators. In this situation, the mentors should always be ready to give necessary assistance to the trainee teachers.

(iii)   Teaching situation concerns

These are concerns about teaching performance, limitations and frustrations of teaching (Clinician & Clinician, 2009). The pre-service teachers are concerned about their own performance in teaching rather than whether the students are learning. This shows that they just teach to impress the mentor or the college supervisor. The pre-service teachers at this stage are concerned about the methods and materials of teaching, prompting them to explore new ideas and possibilities for their lessons.

(iv)   Students' concerns

At this stage, according to Stroot *et al.* (1998), pre-service teachers are concerned about students' needs. This means that they look for new ideas to provide a variety of strategies according to the learners' needs. They begin to see students as individuals with different needs that require separate attention (Stroot *et al.,* 1998).

According to Zeichner and Liston (1987), the goal of teacher education is to integrate theory and practice during the process of "learning to teach". Darling-Hammond (2006) and Kelly and Tannehill (2012) support this idea by saying that the primary purpose of teacher education programmes is to develop the pre-service teachers' knowledge of what teaching is all about, in theory and in practice. This implies that if pre-service teachers are to develop such knowledge, which is different from their own experiences during their time in schools, they need to be exposed to teaching opportunities that allow them to study and reflect on their practices. Field experience, commonly known as "teaching practice", has historically become the core

component of training programmes, which assist pre-service teachers to experiment with the theory learnt in colleges in order to try the art of teaching before they become trained teachers (Kiggundu & Nayimuli, 2009; Santagata *et al.*, 2007). Van den Bos and Brouwer (2014) also contend that universities have realised that prescriptive transfer of theory is not adequate in the learning of pre-service teachers and that the expectations of teaching practice can hardly be met by content only. Theory is thus regarded as insufficient in conformity with reality and with the complexity of actual field practice (Cohen, Manion & Morrison, 2007). The submissions alluded to above emphasise the importance of teaching practice as the best way of "learning to teach", discouraging the tradition of ingraining theoretical knowledge in pre-service teachers without implementation. It is generally assumed that experience is the best teacher, thus most teacher preparatory programmes have adopted teaching practice as the core element in training teachers. This implies that teaching practice has become a prerequisite for a teacher to attain a teaching qualification.

Even though the importance of teaching practice (TP) in assisting students to gain real classroom experience, which is required for quality teaching, is acknowledged, the term "experience" has been misconceived. This is because the term is often measured in terms of the passage of time rather than the extent of professional development. Hurrell (2013) also explains that teaching experience and expertise are often confused. He contends that teaching experience does not equate to teaching expertise. Teaching practice, coupled with a reflection on classroom experiences and the enactment of identified changes, can equate to teaching expertise (Hurrell, 2013; Kleickmann *et al.*, 2013). This coincides with suggestions by Sheafer (2014), who states that teaching experience only becomes educational if students reflect on their experiences and develop new perspectives. When experience is lauded, it does not therefore guarantee trustworthiness in pre-service teachers' professional growth. Furthermore, since "learning to teach" can be considered a cognitive and/or behavioural change, (Haser, 2010), teaching practice is not a consistent process without change. Thus, teachers may not become proficient in how to deal with students' issues by the number of years they have been in the field. The fact that Zimbabwean colleges' mathematics pre-service teachers

spend a year on teaching practice is therefore not enough evidence that they will change for the better.

Tarman (2012) notes that the beliefs, expectations and prior experiences of pre-service teachers affect the way they teach. However, he contends that no matter what beliefs and expectations pre-service teachers hold about teaching, the concern is how these beliefs change as pre-service teachers gradually develop during field experiences. He adds that pre-service teachers sometimes discover that what they know about teaching and schooling is divorced from their actual experiences during teaching practice. They need to see how these beliefs and expectations match with practice and how they can develop a better awareness of what actually takes place in the classroom during learning to teach.

Depaepe *et al.* (2015) and Tarman (2012) highlight important findings about pre-service teachers' beliefs about teaching as follows:

(i) Pre-service teachers' beliefs are established by the time they reach the college. This means that when they join the university, they already have preconceptions of teaching and learning mathematics (Fermann-Nemser *et al.,* 2001). Therefore, new information is filtered through their beliefs.

(ii) Adults do not change their beliefs very often (Depaepe *et al.*, 2015). This is confirmed by the reality of the expression "you can't teach an old dog new tricks". In the same context, Cranton (2006) posits that adults learn because of the transformation of their mind-set. This suggests that pre-service teachers' pre-conceived ideas and beliefs need to be challenged in such a way that they adopt new lines of thinking.

(iii) When changes do occur, they only happen as a result of conversion from being a student to being a teacher, otherwise the beliefs remain unchanged.

(iv) Beliefs that come from personal experiences, schooling, instruction and formal knowledge influence the way pre-service teachers see things. Sometimes these experiences may be unreliable in guiding teacher education to the reality of pre-service teachers. Thus, beliefs need to be compatible with what happens in practice.

The above four issues regarding pre-service teachers will be interrogated and

clarified further in the subsequent sections.

Previous studies have shown that researchers, educators and pre-service teachers have different views about teaching practice during the process of "learning to teach". Because of the concerns of pre-service teachers, teacher educators should prioritise the transformation and development of pre-service teachers' beliefs and perceptions. This study, therefore, sought information concerning the beliefs, views and expectations about teaching held by pre-service teachers as they begin and complete the teacher preparation programme and how these can be improved by field experiences. The study established why pre-service teachers chose to be teachers, because what prompted them to be teachers is likely to affect their attitude towards teaching, hence, influencing the way they teach. The research identified the actual teaching experiences/activities that change pre-service teachers' beliefs and examined the factors that are likely to influence the difference between entering and exiting beliefs. In summary, "learning to teach" is the provision of knowledge for teaching before, during and after teaching practice, within the period of training as a teacher.

2.2   Components of mathematics teachers' knowledge

According to Shulman (1986), pre-service teachers need some kind of knowledge to be effective during their teaching career. To this end, Kessel (2009) contends that there is no single way in which teachers are taught mathematics for teaching but the major concern is "what mathematics should be taught, how should it be taught and what effect does it have on teachers' mathematical practices and dispositions?" The following are components of mathematics teachers' knowledge:

2.2.1 Content knowledge

Shulman (1986) identified different types of mathematics knowledge for teachers. He refers to content knowledge (CK) as the amount and organisation of the subject matter knowledge of the teacher. Shulman (2003) also defines content knowledge as the teachers' knowledge about the subject, for example, the structure of mathematics. It also involves knowledge of the concepts that include principles and definitions (conceptual knowledge) and knowledge of the procedures, sequences and algorithms in problem solving (procedural knowledge) (Shulman, 1987).

Consistent with this, content knowledge (knowledge of mathematics) consists of the nature of mathematics and the mental organisation of teacher knowledge (Turnuklu & Yesildere, 2007). The above ideas refer to the teachers' conceptual understanding of mathematics, which influences classroom instruction in a positive way (Turnuklu & Yesildere, 2007).

According to Ball *et al.* (2001), this kind of knowledge is measured in terms of teacher characteristics and qualifications, which include degrees, diplomas, certificates and other credentials that teachers may possess. It is believed that the more qualifications teachers have, the more effective they become. This means that the content of the subject matter determines the effectiveness of the teacher. Ball *et al.* (2001) and Rice (2003) cite evidence that earning a college degree in mathematics, being certified in mathematics and being mathematically skilful, contribute to the effective teaching of mathematics. Consistent with this, most studies have reported that the more undergraduate mathematics teachers have studied, the better their students perform (Kahan, Cooper & Bethea, 2003; Kessel, 2009). Although this exhibits the importance and contribution of teacher qualifications to students' achievement, Kessel (2009) reports that the issue of qualifications regarding achievement mostly works for advanced mathematics. However, researchers need to consider the quality and nature of the qualification and its relevance to the profession. For example, as far as teaching knowledge is concerned, the difference between a degree and a diploma in mathematics may be negligible when teaching lower level mathematics students (such as form 1 or 2). In such circumstances, it is the style and methods of content delivery that matters.

Some education research studies have shown that it is still disputable whether a degree in mathematics is better than a degree in mathematics education and they recommend that this needs more scrutiny (Floden & Menikketi, 2005). The committee on the study of teacher preparation programmes in the US (2010) asserts that there is very little research establishing the link between teacher content knowledge and students' learning. This gap shows the need for further studies on whether the teachers' content knowledge has a direct effect on students' achievements. However, several studies have shown that many teachers lack confidence and content knowledge in teaching mathematics (Hurrell, 2013). As

revealed in the study by Askew (2008), many prospective teachers exhibited weaknesses in showing confidence when teaching mathematics. Furthermore, Ball *et al.* (2005), Hill, Rowan & Ball (2005), Tsao (2005), and Van Es and Conroy (2009) testify that empirical evidence suggests a lack of conceptual understanding of mathematics content by most teachers. On analysis of these ideas, pre-service teachers can hardly deliver if they lack mathematics content knowledge because people are only able to give what they have. Kessel (2009) thus suggests that a teacher needs to have the ability to solve problems and to present the solution to the students with confidence if effective teaching is to take place.

2.2.2 Pedagogical content knowledge (PCK)

Shulman (1986) identifies the concept of pedagogical content knowledge (PCK) which GroBschedl *et al.* (2014), Richardson-Koehler (2011) and Waghorn and Stevens (1996) regard as the intersection of content and pedagogy. In the same context, GroBschedl *et al.* (2014) regard it as the amalgam of content and pedagogy. PCK gives pre-service teachers an understanding of the mathematics to teach, the strategies to be used with certain kinds of students, particular topics and different learning settings (Shulman, 1987). To this end, teaching expertise may be enhanced. An, Kulm and Wu (2004) assert that PCK has three integrated components of effective instruction in mathematics. These are content knowledge, curriculum knowledge and knowledge of teaching the core component or teaching knowledge.

According to Shulman (1987), previous researchers treated subject knowledge and pedagogy as mutually exclusive bodies of knowledge in teacher education. This resulted in most teacher preparatory programmes focusing on either one but not both. PCK, according to Shulman (1986) and concurred by Weimer (2008), was introduced to be the interplay between the two entities. This involves knowledge of the teaching strategies that suit specific topics and specific individuals or knowing how to arrange certain elements of the content so that the concepts are teachable (Koehler, 2011). Kahan *et al.* (2003) and Turnuklu and Yesildere (2007) explain that the common belief among researchers and societies is that a teacher who knows mathematics well is the best suited person to teach the subject and that students

gain from him/her. However, this view is made regardless of the teacher's ability to present the concepts to the learners. Kahan *et al.* (2003) thus advise that content knowledge alone does not suffice for good teaching.

PCK includes knowledge of the students' difficulties and their misconceptions and fosters meaningful understanding of the subject. Hence, Shulman (1986) advocates for PCK as it involves knowledge of content and students as well as knowledge of content and teaching. With PCK, subject expertise and general pedagogy across disciplines are not treated as separate and independent but are treated as intertwined entities. Shulman (1986, p. 9) notes that in order for teachers to be successful, both issues need to be confronted by embodying "the aspects of content most germane to its teachability". This suggests that the main concern of PCK is to find ways and means of transforming content so that it is presented to the learners in a comprehensible manner. The focus of PCK is thus on the ability to transform the content into a form that is teachable to a specific group of students. Shulman (1986) is therefore concerned about the content and how it is presented to the learners.

According to Depaepe *et al.* (2015), Shulman's theory on teacher knowledge has been influential in teacher education, especially in science and mathematics. It also assists in making mathematics and science concepts comprehensible to learners (Shulman, 1987). Furthermore, Moore (2005) posits that if pre-service teachers are to teach for diversity, they need to enhance their PCK. This is the knowledge of the subject matter for teaching (Shulman, 1986). However, Moore (2005) asserts that pedagogy of teacher education is not just a mere transmission of information about teaching and concludes that teaching about teaching is challenging.

According to Kleickmann, Richter and Kunter (2013), Schmidt and Maier (2007) and Tatto and Senk (2011), universities and colleges contribute plenty to the development of PCK. However, some researchers, such as Schmelzing *et al.* (2013), still feel that PCK is developed from teaching experience. An analysis of the two points of view reveals that since there is interplay between theory and practise during teaching practice, the universities and teacher experiences have a role to play in the development of this skill. Shulman (1987) states that PCK addresses two issues; firstly, it addresses the presentation of the subject matter using appropriate

strategies of instruction and resources in a way that is understood by the students. The second issue concerns the conceptions and preconceptions of the subject matter. This is what students understand about the mathematics they learn.

2.2.3 Mathematics knowledge for teaching (MKT)

Researchers have different views on what teachers need to know about mathematics in order to teach it effectively. There is an assumption that teachers need to know everything that is in the curriculum they will teach and they require some "deeper" knowledge normally acquired from their training universities. Nevertheless, researchers are still sceptical about the "extra knowledge" that pre-service teachers need to have (Ball *et al.*, 2008). This led to the introduction of mathematics knowledge for teaching (MKT) by Ball *et al.* (2008) which was a refinement of Shulman's PCK.

According to Kessel (2009), mathematics knowledge for teaching is an application of mathematics to the practice of teaching or, in simple terms, is the mathematics that teachers need to know. The introduction of mathematics knowledge for teaching sought to answer the question on what exactly teachers need to know and do in order to teach mathematics effectively. PCK was refined into mathematics knowledge for teaching which established the relationship between content knowledge (CK), pedagogical content knowledge (PCK), teachers' instructional behaviour and students' learning outcomes (Ball *et al.*, 2001). In line with this, Ball, Depaepe *et al.* (2015) construe knowledge of subject matter for teaching as comprising knowledge of instructional strategies and representations as well as knowledge of students' misconceptions. This suggests that the teachers' ability to use appropriate teaching approaches to make information accessible to the pupils implies knowledge for teaching mathematics.

Whilst PCK is concerned about content first and how it can be transformed into teachable aspects, MKT explains the idea of knowledge in teaching or knowledge for teaching and not knowledge on teachers (Ball *et al.,* 2008). This shows that MKT is concerned about "teaching" which is how to present a task to the students, showing them how to solve the tasks, answering students' questions, how to correct errors and explain procedures without ruling out the knowledge of the subject matter. Ball

et al. (2008) defines MKT in simple terms as everything that is needed to carry out the teaching of mathematics. She emphasises that the definition focuses on the "teaching" and not on the "teacher"; hence, mathematics knowledge in teaching or knowledge for teaching and not knowledge on teachers as alluded to above. It shows therefore that MKT demands clear representations of concepts and procedures in the classroom in order to avert misconceptions of ideas among pupils. In line with this, Kessel (2009) contends that mathematics knowledge for teaching allows the teacher to assess students' work, the root of errors in the classroom and an understanding of the mathematics taught. With mathematics knowledge for teaching, the teacher is in a position to identify and nurture the talent in a student (Kessel, 2009). This assists pre-service teachers to realise that students have their own knowledge and talents before they impart new information. Learning takes off when students are able to compare and contrast what they have with what the teacher has given them.

The pre-service teachers' knowledge of MKT assists them in identifying topics that are difficult for the students, how to present the topics in a way that they understand (Kessel, 2009) and assists students to see the link between topics that are taught. For example, from my experience, figure 2.1 is a problem that can be solved by forming three equations to be solved simultaneously to get the weight of each animal. However, when this question was asked to a 13-year-old boy who was not privy to simultaneous equations, the expectation was an "I do not know" answer but he gave the correct answer by applying previously acquired knowledge and not by applying simultaneous equations. The explanation was as follows: From left to right, the boy looked at the second and third pictures in which one animal (dog) was common. Therefore, the difference of four was between the cat and the rabbit. Looking back to the first picture (cat and rabbit), the two animals' weight totalled 10 whilst the difference should be four. He had to think of two numbers with a sum of 10 and difference of 4.

Figure 2.1: Mathematics Knowledge for Teaching

However, one of the numbers had to be greater than five because the cat and the rabbit are not the same size. The two numbers were 7 and 3, implying that the dog is 17 (20 – 3 or 24 – 7) kg. From the above example, the student was able to construct knowledge from what he already knew.

Turnuklu and Yesildere (2007) assert that teachers have to be very meticulous about students' ways of thinking when teaching mathematics. They also contend that if teachers fail to translate abstract concepts into a form that enables students to relate the mathematics they learn to what they already know, then learning with understanding is not achieved. With mathematics knowledge for teaching, a teacher is not only restricted to the analysis of errors but to how the correct answer is obtained. Teachers must therefore not make assumptions about students' knowledge regardless of whether they have done the topic or not.

Students need a setting conducive to learning in order to work autonomously with confidence (Maphosa *et al.,* 2007). An analysis of the above ideas shows that by involving students in the learning process, teachers create a sound relationship between themselves and the students. A lack of attention can result in academic failure. Billington and DiTommaso (2003) and Skinner, Pappas and Davis (2005) explain that attention is the primary vehicle for improving motivation and motivation leads to engagement. They add that people tend to engage when they are interested, thus, classroom instruction needs to capture the students' attention (Blumberg, 2005).

Adler (2005) asserts that unlike mathematicians, mathematics educators need to equip pre-service teachers with the skills to analyse problems that arise in the classroom so that they understand their students better. For example, they should be able to do an error analysis of the students' responses in a given exercise. For instance, after asking the students to solve a problem like -2(x + 3), the pre-service teacher may be faced with the following answers from the students: -2(x + 3) = -2x + 6, or -2(x + 3) = (x + 3) – 2. Realising that the answers are right or wrong is not enough for teaching. The teacher should be able to do the procedures and notice the root of the problem (Richardson-Koehler, 2011). In the first case, the student has problems with expanding the brackets. The negative sign outside the brackets has

only affected the first number inside the bracket and the other term maintained its sign. In the second example, it seems the student has the knowledge of 'commutativity in multiplication'. Therefore, to the student, starting with -2 multiplied by the bracket is the same as multiplying the bracket by -2 (-2 coming after the bracket). The student perceives it as if the meaning of the expression has not changed yet in fact, the multiplication concept has been subsumed by addition. It may not be possible for pre-service teachers to teach these operations if they do not understand where the problem is emanating from. After interpreting and evaluating the root and nature of the error, it is therefore appropriate for the teacher to do the problems and correct the students.

If pre-service teachers are well equipped with this kind of knowledge, students may shift their line of thinking which may result in mathematical proficiency. Consequently, Moore (2005) proposes that pre-service teachers become mathematically proficient so that they are able to teach in a way that learners also become mathematically proficient. The ability of pre-service teachers to assess and describe mathematical practices results in knowing mathematics for teaching (Ball *et al.*, 2005).

The discussions above suggest that teaching mathematics is a skill that every pre-service teacher needs to acquire. Content alone is of limited importance and serves as a basic minimum qualification. Hill *et al.* (2005) and Hine (2015) recommend that mathematics teachers need not be able to calculate problems only but to know how to present and communicate the concepts to the learners for understanding. However, from a number of studies that were conducted on teacher knowledge, Ball *et al.* (2001) find that the debate around teacher knowledge needed for mathematics teaching remains unabated.

2.2.4 Field experiences

He, Means and Lin (2006) and Jusoh (2012) contend that almost every teacher education programme incorporates field practice because it is considered essential for pre-service teachers' professional development. Furthermore, research by Kiggundu and Nayimuli (2009) and several other studies that include the Committee on the Study of Teacher Preparation Programmes in the U.S. (2010), advise that

every trainee teacher should have field experiences because this is when they experience the complexities of the reality of teaching. This suggests that regardless of how teaching practice is organised in an institution, field experiences enable pre-service teachers to acquire the skills and competencies to be a teacher. Kessel (2009) also asserts that it is through field experiences that students see the amalgamation of theory and practice for the first time. During teaching practice, pre-service teachers have an opportunity to observe and assist with classroom activities, examine problems that arise in the classroom and apply theory from their coursework (Kessel, 2009). Teaching practice also allows pre-service teachers to develop their pedagogical skills (Gulamhussein, 2013; Puckett & Anderson, 2002).

However, the question is, how long does it take teaching practice to become effective on pre-service teachers' performance? Most researchers are not clear on the length of time that should be spent by pre-service teachers on teaching practice to yield results on their performance. In addition, previous research has failed to establish the connection between field experiences and teacher effectiveness, suggesting that the debate on how effective teaching practice is on teacher knowledge continues.

For field experiences to be successful, pre-service teachers are given an opportunity to work with people and to take part in many activities (Acquah & Partey, 2014). The university instructors work in collaboration with the classroom teachers and they supervise the pre-service teachers. At the same time, the classroom teachers assume the role of guiding, counselling, supporting, supervising, critiquing and instructing pre-service teachers (Maphosa *et al.,* 2007). The relationship between the mentor, pre-service teacher and the university teacher educators is therefore a crucial part of any teaching experience during teaching practice (Goodnough *et al.,* 2009).

Field practice is normally overwhelmed with challenges (Kelly & Tannehill, 2012). Tan (2008) posits that the challenges include establishing good rapport, getting support from the mentor, putting theories into practice and classroom management. These challenges are likely to affect pre-service teachers' performances if they are not addressed. Some of the problems also involve maintenance of collaborative

relationships between universities and practising schools, communication between all parties involved and limited time for universities to visit pre-service teachers in their practising schools (He *et al.,* 2006); even though the number of times pre-service teachers are to be visited is not prescribed.

In the case of poor performance by pre-service teachers, the schools, universities and the pre-service teachers themselves may deny responsibility, hence shifting the blame to each other. Once the relationship between colleges and practising schools is impaired, support for pre-service teachers may be hampered. Without support, pre-service teachers lose that sense of belonging to the teaching and learning community (Edens, 2000; Howey, 1986; Ishler, Edens & Berry, 1996).

2.3   Sources of teacher knowledge

Kennedy (2002) and Leikin and Levav-Waynberg (2009) classified teacher knowledge based on the following sources:

(i)   Craft knowledge

Craft knowledge is largely developed through experience and is based on the interaction between teachers and their students. Consistent with this, Cooper and McIntyre (1998) assert that craft knowledge is firmly rooted in teachers' practical experiences. However, Cooper and McIntyre (1998) state that craft knowledge is linked to the daily practices of pre-service teachers and that it describes the knowledge that arises from what pre-service teachers actually do. This means that craft knowledge is not theoretical but practical in nature. Mathematics pre-service teachers develop this kind of knowledge through practical problem solving approaches (Cooper & McIntyre, 1998), suggesting that knowledge is attained when students are involved in hands-on experiences. English and Kirshner (2010) also confirm that craft knowledge is an action-oriented source of knowledge that informs what pre-service teachers do. This knowledge source assists pre-service teachers to address the concerns about students' willingness to participate in the classroom because it is based on practical work (Kennedy, 2002). Because of its practical nature, mistakes are therefore rarely repeated (Kennedy, 2002). This suggests that practice is effective in training a teacher. Teaching practice therefore becomes the first training ground for mathematics pre-service teachers to develop craft

knowledge.

(ii)   Systematic knowledge

This is acquired by participating in communities of learners, for example, studies in colleges and universities, pre-service teachers' programmes of learning, reading articles, journals and professional books as well as getting involved in professional development studies. Kennedy (2002) asserts that even though systematic knowledge is a good source of knowledge, it is theoretical and abstract. Unlike craft knowledge, systematic knowledge is not action-oriented. Systematic knowledge, according to Kennedy (2002), addresses concerns about fostering students' learning in a theoretical manner. However, there is no guarantee that ideas will be acquired during theoretical teaching (Kennedy, 2002).

(iii)   Prescriptive knowledge

This source of knowledge is prescribed by institutional policies, and even though it is less theoretical than systematic knowledge, it is more codified than craft knowledge (Kennedy, 2002). Prescriptive knowledge usually consists of statements associated with "should" or "ought to" that seek to enforce action (Kennedy, 2002). Owing to its commanding nature, prescriptive knowledge contains an air of certainty because knowledge is attained through strictly following prescribed policies, rules and procedures. Prescriptive sources normally include curriculum standards and guides, specific textbooks, tests and accountability systems that have to be strictly adhered to. According to Kennedy (2002), it is invoked to resolve concerns about what should be taught or what students should learn. This source of knowledge, however, tends to be transient because nations, districts, schools and teachers change policies, curricula and study materials (textbooks) regularly.

2.4   The role and benefits of field experiences during learning-to-teach mathematics

Hamaidi *et al.* (2014) define practical knowledge (practicum) as a programme that provides a meaningful field experience offered by the department of teacher education at a university. It is also the time that pre-service teachers spend in schools practising actual teaching. According to Hamaidi *et al.* (2014), the success of a teacher does not only rely on theoretical knowledge but includes practical

knowledge. Research in teacher education has therefore focused on teaching practice, its importance in the development of pre-service teachers and the impact on their future career (Gan, 2013; Martin, 1998; Soylemez & Tuga, 2014). However, the nature, length and frequency of practicums vary between institutions (Jusoh, 2012).

Even though there is enough evidence indicating that changing what teachers do in the classroom is difficult (Jita & Mokhele, 2013), pre-service teachers, according to Hamaidi, *et al.* (2014), develop their behaviour and practices as they become efficient in having a clear understanding of the school culture, recognising and realising students' real needs in the classroom during teaching practice. This shows that their professional and personal competences are enhanced during teaching practice.

Some researchers argue that the theory and practice of teaching and "learning to teach" are inseparable (Bennett & Turner-Bisset, 1993) because they believe that "learning to teach" without practice is futile. Field experience, commonly known as teaching practice, is therefore recognised as the most important aspect of teacher education programmes, prompting Hamaidi *et al.* (2014) to call it the core element of teacher education. Santagata *et al.* (2007) also demonstrate how the National Commission on Teaching and America's Future (NCTAF) (1996) report and other influential bodies in the United States of America (USA) have consistently drawn attention to the important contribution that teaching practice makes in preparing pre-service teachers to handle the complexity and challenges of the school and classroom contexts. In addition, Sheafer (2014) states that it is one thing to read about teaching and learning in a textbook but it is another to see teaching and learning actually taking place. This illustrates how theory is different from practice and implies that what students learn in the classroom becomes meaningful if it is demonstrated in real life. The teaching practice component enables pre-service teachers to become more aware of the realities of teaching contexts. Teaching practice time, according to Gan (2013) and Hamaidi *et al.* (2014) is when student teachers portray their creativity, talent and ability to marry university-acquired knowledge with practice, thereby understanding the real world of teaching. Van den Bos and Brouwer (2010) thus assert that new experiences during practice trigger

some new lines of thinking among pre-service teachers. This means that teaching practice assists pre-service teachers to reconceptualise their ways of thinking about teaching.

Hamaidi *et al.* (2014) and Jusoh (2012) identify three phases that pre-service teachers undergo during teaching practice. First, pre-service teachers are engaged in the observation of lessons taught by experienced teachers with the guidance of the mentors. They then comment on the lesson and the practices of the mentors. The second phase is partially teaching participation. This is when they teach with the assistance of the expert teacher. Lastly, there is solo teaching. This is when pre-service teachers teach a class on their own.

Through observation, imitation, experimentation and other experiences, pre-service teachers' understanding of integrating theory and practice is expedited, thereby prompting a gradual transition from the novice stage to the proficient stage. However, it is questionable whether this is actually happening. Palsdottir, Gunnarsdottir and Kristinsdottir (2008) propose that lessons offered by pre-service teachers during teaching practice should be treated as experiments so that pre-service teachers can learn from them. However, an experiment can fail or succeed, which implies that mistakes, faults and blunders are expected during teaching practice. Learning from them can enhance pre-service teachers' professionalism. Teacher preparatory programmes, therefore, have a role to play in preparing pre-service teachers for any difficulties they may encounter during teaching practice (Haser, 2010).

According to Palsdottir *et al.* (2008), pre-service teachers need to be responsible for their own professional development and teacher preparation programmes are only the starting point of "learning to teach". However, the entire process of teaching practice is neither designed nor restricted to a single person. Gan (2013), who explains that practicum delivery emphasises a team approach where the mentor, college supervisors and the pre-service teachers cooperate to provide intensive modelling and coaching, confirms this. Endeley (2014) thus asserts that the richness of teaching practice is dependent on the quality of the supervisor. Jusoh (2012) and Nicol and Crespo (2003) further contend that teaching practice is not only confined to

the classroom but also includes everything that the teacher does. This communicates the idea that effective "learning to teach" does not just mean knowing what to teach and how to teach it but also how to relate to others.

The main assumptions of teaching practice that applies to all programmes, according to Santagata *et al.* (2007), exposes pre-service teachers to examples of teaching that create learning opportunities. It therefore implies that teaching practice is likely to form the basis of an effective teacher and may be the best way to transform pre-service teachers' behaviour (Snyder, 2012). The idea explains that if properly executed, teaching practice can shape pre-service teachers' way of "learning to teach".

2.5 Pre-service teachers' beliefs, preconceptions and expectations about "learning to teach" prior to teaching practice

According to Schonfeld (1992), "mathematical beliefs" are defined as individuals' intuitive understanding of something that directs the way they conceive mathematical ideas and engage in mathematical behaviour. Yilmaz and Sahin (2011) simply define beliefs as the preference of doing something. In this study, beliefs are interpreted as those conceptions held by pre-service teachers about mathematics teaching and learning. Frydaki and Mamoura (2011) and Yilmaz and Sahin (2011) contend that concerns and beliefs are pivotal aspects of teacher knowledge because most learners view the world through the lenses of their interpretation of events and then act according to the way they understand the world. According to Peressin *et al.* (2004), Briley (2012), Joram and Gabriele (1998) and Richardson (1996), pre-service teachers' beliefs are directly linked to their classroom practices and thus knowledge and beliefs about teaching have become major determinants of what teachers do in the classroom. The goal of teacher education is therefore to acquire new knowledge and new beliefs that promote "learning to teach" (Peressin *et al.,* 2004), hence, Yilmaz and Sahin (2011) concur that beliefs about teaching stimulate change and the adoption of new strategies in the classroom.

Since beliefs affect pre-service teachers' instructional practices and conceptions of teaching and learning (Chan & Elliot, 2004; Kagan, 1992), it is important to be aware

of these beliefs in order to improve their classroom practices and foster the teaching and learning of mathematics with understanding. Pre-existing beliefs may be maintained if they positively relate to the demands of teacher learning (Peressin *et al.,* 2004) but if they are incompatible with the students' needs, they can be shaped and reshaped through social interaction relevant to the students' specific needs (Barahona, 2014). However, Briley (2012), Depaepe (2015) and Tarman (2012) contend that beliefs cannot easily be altered and that pre-service teachers' mathematical beliefs do not necessarily change during teacher preparation programmes. This is in line with the assertion by Nespor (1987) that the earlier a belief is inculcated into the belief system of an individual; the harder it becomes to change. This suggests that pre-service teachers' long-standing beliefs that were inherited from high school may be difficult to mitigate. A study by Snyder (2012) shows that pre-existing beliefs of pre-service teachers can only change through experiential learning. Although most researchers agree with this viewpoint, they have not determined how this transformation can be measured (Snyder, 2012).

Grouws, Howald and Colangelo (1996) developed a theoretical framework of mathematical beliefs for teachers, which are divided into seven dimensions. These are further divided into four categories as shown below.

(i) Beliefs about the nature of mathematical knowledge
   This category involves beliefs about the composition, structure and status of mathematical knowledge. For example, mathematics can be viewed as a collection of unrelated, isolated facts or as coherent concepts (Grouws *et al.,* 1996).

(ii) Beliefs about the character of mathematics activity
   This second category includes doing mathematics and proving theorems. Doing mathematics involves recalling and obeying the appropriate rules (Lampert, 1990). Mathematical ideas are validated and this may be perceived as implementing procedures or as making sense of concepts. This is exemplified by the application of the quadratic formula to solve problems or how the quadratic formula is derived from completing the square of a quadratic equation.

(iii) Beliefs about the essence of learning mathematics

41

The third category demonstrates whether mathematics should be memorised or understood. The beliefs also involve whether mathematics is about finding correct answers or following procedures.

(iv) Beliefs about the usefulness of mathematics

The forth category answers the question whether the mathematics that is taught has any value in real life, that is, whether mathematics is useful in people's everyday lives. For example, learners may question the use of integration or differentiation in their lives and this is likely to determine their attitude towards the topics.

Each category may have naive beliefs or sophisticated beliefs but an individual can possess both (Briley, 2012). It is these beliefs that may direct pre-service teachers' approach to teaching mathematics during "learning to teach".

Regardless of the above categories of beliefs, all teachers' beliefs about teaching fall under two indices (Organisation for Economic Cooperation and Development [OECD], 2009) which are the direct transmission (traditional) beliefs about teaching and the constructivist beliefs about teaching. The constructivist view of teaching is underpinned by the belief that knowledge is tentative and changeable, which explains that the teacher's ability to teach is not innate. The pre-service teacher's "learning to teach" therefore depends on study rather than skill (Yilmaz & Sahin, 2011). In this context, a constructivist teacher is keen to learn various ways to involve students actively in the learning process. According to Chan and Elliot (2004), the more students are actively involved in the learning process, the more they become engaged and this is likely to bring about learner achievement. A pre-service teacher with constructivist beliefs is therefore more likely to be positive about teaching and is potentially prepared to face challenges. Pre-service teachers with direct transmissions (traditional) conceptions are likely to hold beliefs that knowledge is certain and unchanging (OECD, 2009). The role of the pre-service teacher with such beliefs is to disseminate knowledge to the learners with the teacher being the source of information during the "learning to teach" process.

Teachers' beliefs and expectations about teaching play a powerful role in "learning to teach" (Lee, 2003). Teacher educators thus need to pay attention to how these

beliefs assist or hinder pre-service teachers' learning. According to Barahona (2014), teaching should influence pre-service teachers' conceptions about teaching, learning and learners. These conceptions are normally influenced by professional experience, history, identity and teacher preparation of pre-service teachers. This shapes the pre-service teachers' decisions about teaching practice and their future actions.

Many studies (Briley, 2012; Eisenhardt *et al.,* 2012; Lee, 2003; Rena, 2010; Wideen *et al.*, 1998) have demonstrated that pre-service teachers' characteristics, pre-determined beliefs and misconceptions about teaching affect their experiences in teacher education. Barahona (2014) contends that many U.S. scholars believe pre-service teachers' beliefs about students, the nature of knowledge, learning and teaching shape their perceptions about teaching practice. In the same vein, Barahona (2014) and Cole and Knowles (1993) established that prior educational experiences and beliefs have become the deciding factor between success and failure for pre-service teachers during teaching practice because they influence what and how they learn. Most of these prior beliefs normally originate from personal experiences as learners, in teacher education programmes, schooling and cultural beliefs. Frydaki and Mamoura (2011) thus suggest that if pre-service teachers' pre-conceptions, beliefs and expectations about mathematics are taken into account and challenged during "learning to teach", good teachers are developed. Teaching approaches, teaching styles and pre-service teachers' thoughts are therefore influenced by their beliefs and their personal theories about the knowledge of the subject they have (Lo & Anderson, 2010). The way pre-service teachers understand mathematics (mathematics content, pedagogy and curriculum), affects the quality of their teaching. Teacher educators must not ignore pre-service teachers' expectations and beliefs because the teacher, as the implementer of the curriculum, determines the learners' achievements.

Pre-service teachers have expectations about teaching before teaching practice, which normally exclude some basic knowledge of time limitations, students' motivation and diversity among learners (Haser, 2010). This explains the view that pre-service teachers have a mental picture of what they are looking forward to encountering during teaching practice without taking cognisance of the nature of classes they will teach in terms of numbers, cultural differences, timetable

congestion, aptitude, attitude towards mathematics and other unpredictable factors. Most of them, according to Eisenhardt *et al.* (2012), associate the classes they will teach with their own personal experiences because pre-service teachers join the colleges after various teaching and learning experiences. They may want to think that teaching is taken in the direction they have seen it happening (Nicol & Crespo, 2003). For example, if they were taught using the lecture method, their line of thinking about teaching also includes the lecture method. From their study, Nicol and Crespo (2003) established that pre-service teachers expect to become better teachers than the ones they knew. They expect to present the subject to the pupils in a unique way using the most appropriate teaching strategies. Hence, they may enter the profession with expectations and preconceptions about the teaching and learning of mathematics.

According to McDiarmid and Ball (1998), pre-service teachers think that "good" mathematics students are those who are able to remember formulae and procedures and consequently failure to memorise these implies poor performance. In the same context, Peressin *et al.* (2004) also assert that pre-service teachers believe that doing mathematics means finding correct answers quickly and learning mathematics means mastering procedures. According to Wideen *et al.* (1998), pre-service teachers view teaching as a simple transfer of information to the pupils. This is likely to affect their teaching methodologies and, as a result, teaching is based on the teacher and the textbooks. This concurs with the "direct transmission" concept of teaching that is described by the OECD (2009) as a didactic manner of teaching. Pre-service teachers thus consider themselves the sole suppliers of information, which is likely to result in teacher domination in the classroom.

Gan (2013) and Tarman (2012) agree that most pre-service teachers felt that they knew what good teaching is and that they could teach confidently at the beginning of the practicum. They only needed to be equipped with new strategies of teaching. Apart from this, they felt they had all the other skills. When asked to describe what a "really good teacher" is like, Wideen *et al.* (1998) contend that pre-service teachers had an affective concern about teaching. As an indication of being good teachers, they expect to be able to relate to their students well and to practise in a warm, caring, understanding and loving classroom atmosphere (Wideen *et al.,* 1998).

Whilst some of the beliefs and expectations are accurate, most of them are myths (Eisenhardt *et al.,* 2012). This imposes a role on teacher educators to prove, convince and confirm to pre-service teachers that some of their beliefs are not practically possible to apply in the teaching process. However, Lo and Anderson (2010) assert that some of these pre-existing beliefs about teaching can remain intractable.

Studies by several researchers have revealed the majority of the beginning pre-service teachers are the ones who normally hold on to much of the same beliefs as the ones they had before teaching practice, more than graduating pre-service teachers (Anderson & Lo, 2010). This implies that given adequate time for teaching practice, pre-service teachers' beliefs can be redirected to the right course. The idea also reveals the need for longer teaching practice periods. Ferman-Nemser (2001) assert that pre-service teachers begin to learn long before they start their formal education in teacher education. They learn from their parents, from nursery schools and from primary and secondary schools. As a result, they have preconceived ideas of teaching. Some pre-service teachers' have the confidence to teach mathematics when they go on teaching practice because they know the subject content well (Lee, 2010). What is unknown to them is that the tacit understanding of the subject is not productive in the classroom if it remains dormant (Lee, 2010). This knowledge must therefore be put into action by making it comprehensible to the learners; otherwise, it is rendered useless in teacher education.

According to Lo and Anderson (2010), investigations of pre-service teachers' beliefs about teaching mathematics revealed that some pre-service teachers view mathematics as a body of knowledge that is static and that the teacher is an expert in the subject while the students wait to receive knowledge from the teacher, so they can memorise rules and procedures. This belief may create in the pre-service teacher's mind the idea that the teacher is in charge in the classroom and that s/he knows everything while the students are just empty vessels that are waiting to be filled. This mind-set affects pre-service teachers' teaching strategies. It is the role of this study, therefore, to find out whether the teaching of mathematics is appropriately conducted and whether the contribution of teaching practice is significant to mathematics teacher knowledge.

2.6   Pre-service teachers' experiences during teaching practice

2.6.1 The mathematics learnt by pre-service teachers during teaching practice

This section of the literature review looks at the mathematics that pre-service teachers reportedly learn whilst on teaching practice. Ball *et al.* (2005) claim that researchers disagree whether teachers need mathematics for teaching only or require knowledge of advanced mathematics such as calculus and algebra. Kim (2011) argues that teacher knowledge is largely determined by cultural dynamics, which make it difficult to establish the nature of mathematics knowledge that suits all pre-service teachers. More research needs to be conducted to establish what knowledge teachers actually need to boost student achievement.

Mathematics knowledge for teachers is a broad concept that involves different kinds of knowledge that is required for teaching. Research on teacher knowledge is not novel and many researchers have written about mathematics knowledge for teachers but most of them have been wondering what influence this has on the effectiveness of teachers (Ball *et al.*, 2001). Though researchers appreciate teachers' mathematical knowledge, they also have doubts whether it has achieved its purpose of learner achievement in mathematics (Ball *et al.,* 2008). The reason for this is that regardless of the overwhelming research on mathematics knowledge for teachers, it has failed to address the problem of mathematics achievement in high schools.

According to Ball *et al.* (2005), several studies show that mathematics knowledge for teachers is thin and weak and this has impeded effective teaching. Some have advocated for the teaching of mathematics to be used on the job by pre-service teachers during their time on college campuses. To this end, they advocate for teacher preparatory programme curricula to be revamped to include classroom mathematics and curricula materials and to do away with mathematics methods coursework and professional development.

The NCTAF (1996), cited in Ball *et al.* (2001), released a report which proposed that what teachers know, as far as subject matter content is concerned, has a strong influence on what students learn. It further argues that teachers need to know the

content thoroughly in order to make ideas accessible to learners and present the knowledge clearly.

Studies have shown that teachers' qualifications accounted for more than 90% of the variation in student achievement in mathematics (NCTAF, 1996). This suggests that the amount of content knowledge determines pre-service teachers' performance during teaching practice. On the contrary, Ball *et al.* (2001) argue that even though the number of courses taken in mathematics makes a difference, this is only up to a certain point. Other studies also reveal that whether a teacher majored in mathematics or not, this had no effect on students' performance. Simply counting the number of courses taken by teachers does not assist in untangling the problems encountered during lessons (Ball, *et al.,* 2001). This means that, depending on learners' characteristics, content knowledge alone may fail to satisfy the demands of teaching at a particular moment. For this reason, knowing is not synonymous with teaching, although teaching depends on knowledge (Ball, *et al.,* 2001).

Some researchers argue that pre-service teachers need to learn routines and skills that can be applied to any situation at any time, regardless of the subject matter. Others contend that pre-service teachers need to learn particular theories about teaching (McDiarmid & Ball, 1998). This suggests that researchers are concerned about what and how the students learn rather than the content knowledge of pre-service teachers.

On the contrary, other researchers assert that subject matter knowledge does not only include theories and ideas but also an understanding of how knowledge is discovered, organised and tested. This means that they emphasise knowledge on active learning methods rather than mere memorisation of facts, theories and ideas, which students cannot sustain. Leikin and Levav-Waynberg (2009) thus identified two types of mathematical understanding. These are discussed below.

(i)   Instrumental understanding
As described by Leikin and Levav-Waynberg (2009), this type of understanding is used to apply certain procedures to solve mathematical problems without understanding why and how the procedures work. Even though the implementation of concepts of practical situations may be difficult, this form of understanding assists

students in cases where the result of an examination takes precedence. An analysis of this kind of understanding reveals that learners may lack critical thinking, making the learning of mathematics devoid of any value in the education system. This involves, for example, the application of the quadratic formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ on a problem without knowing how and why it was derived. Instead of starting with the simple form of a quadratic equation; $ax^2 + bx + c = 0$ and then completing the square to get the formula, students find themselves grappling with memorising and reciting the formula.

(ii)   Relational understanding

Unlike instrumental understanding, with relational understanding the learners make connections between concepts. According to Leikin and Levav-Waynberg (2009), the learners develop mathematical knowledge from previously learnt concepts. Learners are able to link ideas to solve challenging tasks in mathematics and these ideas can then be applied to new and related ideas. For example, instead of memorising the basic trigonometric ratios of angles 30^0 and 60^0 as: tan 60° = √3, or sin 30° =½, a learner exposed to relational understanding can derive these values from the previously learnt Pythagoras theorem $(a^2 + b^2 = c^2$).This can be done by drawing an equilateral triangle and bisecting it (figure 2.2), applying Pythagoras' theorem to calculate side CD that equals √3. From the diagram, it may be easier for the students to find tan 60° = $\frac{opposite}{adjacent}$ = √3 or sin 30° = $\frac{opposite}{hypotenus}$ =$\frac{1}{2}$, instead of cramming the ratios. This also applies to all the other ratios of tan 30^0, sin 60^0, cos 60° or cos 30^0, to mention a few.
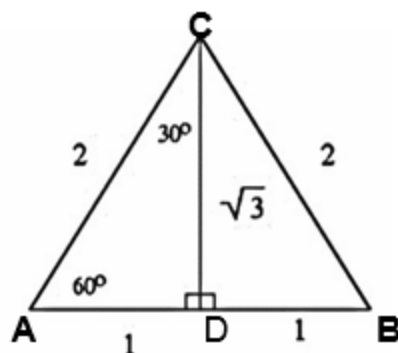
Figure 2.2: Trigonometrical ratios

For this type of understanding, using different approaches is the major tool to

developing the connectedness in mathematical knowledge to solve problems, which may promote quality learning and teaches tenacity among the students (Leikin & Levav-Waynberg, 2009).

However, relational understanding may not always succeed in the classroom because some countries, such as Zimbabwe, have a fixed syllabus that should be covered within a certain time before students sit for their examinations. They are tested on all the topics of the curriculum and if they have not covered all the material, their performance may be affected (Kiggundu & Nayimuli, 2009). However, research shows that it is still not clear which of the two types of understanding is convenient and effective on students' achievement.

2.6.2 What pre-service teachers learn about mathematics teaching during teaching practice

According to Ball *et al.* (2005), mathematics teaching includes everything that teachers do to enhance students' learning. This includes all work that is given to the students in the classroom, planning lessons, assessments, evaluating students' work, management of homework and explaining classwork to parents (Ball *et al.*, 2005). Hamaidi *et al.* (2014) also established that pre-service teachers should be equipped with skills and competences to prepare daily lesson plans, effect classroom management, use appropriate teaching strategies and interact with the students effectively. Ball *et al.* (2005) posit that this constitutes knowledge of mathematics ideas, mathematics reasoning skills and communication with learners.

During their time in college, normally in the first year, student teachers are equipped with theoretical concepts on how to deliver subject content to a third party. They are not only taught the methodology of content delivery but also the subject matter knowledge to raise their knowledge above that of the students they will encounter during teaching practice (Santagata *et al.,* 2007). Ajibade, Oloyede and Adeleke (2010), Ball *et al.* (2001) and Darling-Hammond (2006) show the significant effects of mathematics pedagogy, rather than mathematics content, for undergraduates on pupils' performance. The introduction of pedagogical content knowledge (PCK), Shulman (1986) argues, intertwines content with teaching and learning, which shows that mathematics teaching involves mathematics content knowledge and

pedagogical content knowledge.

Cochran, DeRuiter and King (1991), on analysing Shulman's view of PCK, postulate that it enables the mathematics teacher to disseminate subject knowledge to the pupils because the teacher's understanding of the subject matter is of no importance if it cannot be communicated to the pupils. It is this knowledge that marks the difference between a mathematician and a mathematics teacher. This implies that knowing mathematics for oneself is not the same as knowing how to teach it. This confirms Ball's *et al.* (2001) view that deep content is not adequate unless representations of students' difficulties with particular ideas are known. PCK, hence, encompasses more than what is taught in mathematics courses at teachers' colleges.

Researchers also believe that good teaching defines students' achievements. This explains the point that the teacher mainly determines effective learning. This may be the reason why most researchers explore mathematics knowledge for teachers to enhance student achievements. Zimbabwean universities have therefore, taken strides in training graduates who have content knowledge to be teachers with pedagogical knowledge of the subject, leading to the graduate certificate in education (Grad. CE) programme.

Research in mathematics education has shown that the kind of teaching that develops mathematical connections in students' minds is the mathematics knowledge that is deep and connected (Ball *et al.*, 2005). Ball *et al.* (2008) and Schneider and Plasma (2011) hence emphasise knowledge in teaching and knowledge for teaching rather than knowledge on teachers. Mathematics knowledge for teaching (MKT), as a refinement of PCK, was therefore described as the most influential aspect in learning to teach within teacher education (Depaepe *et al.*, 2015). Pre-service teachers therefore need more than subject matter knowledge for effective teaching (Ball *et al.,* 2001; Hill, Ball & Schilling, 2008).

With the knowledge of MKT, teachers know the level, the sequence and the methods used to teach certain ideas and topics in mathematics (McDiarmid & Ball, 1988). During teaching practice, pre-service teachers should therefore be able to organise learning activities for diverse learners and individualise instructional programmes for

children who require it. However, Muir *et al.* (2013) established that most pre-service teachers think that they are not being adequately prepared to teach students of different abilities. They base their arguments on the facts that there is limited time to learn about inclusive education during their time in college and insufficient background on inclusive education during their time in school. A study by Muir *et al.* (2013) also revealed pre-service teachers sentiments on how they are prepared for professional roles. Muir *et al.* (2013) reports that pre-service teachers are not satisfied with the way they are prepared for such roles especially because of the limited places for practicum. When they are placed in schools, they feel that they are not fully equipped with the skills to teach students with additional needs in the classroom.

According to McDiarmid and Ball (1988), during field practice, pre-service teachers need to have an understanding of the socio-cultural context of the classroom and the school community so that they are able to teach for understanding. For example, a pre-service teacher, regardless of his/her qualifications, can provide a clear explanation on how a pupil can get an algebraic expression from words. A teacher's pedagogical knowledge should allow him/her to assess the children's background environment before generating the word problem. Word problems involving "cricket players" or the "two of hearts" (of playing cards) for students who are not familiar with these terms are meaningless. Such problems hide the conceptual foundation of algebra for these students and are liable to hindering their understanding of the topic. If familiar terms or local games are used in the example, then they may be able to understand and see the value additions and benefits of learning algebra. The example shows that even though a teacher needs content to teach, the content does not make information accessible to the pupils. Similarly, a Master's degree in algebra may do very little to assist such pupils if the teacher is not pedagogically equipped.

Borko *et al.* (2000) suggest that mathematics tasks should convey the message that the tasks must connect with the children's real world. Teachers therefore need to know the school curriculum, the learners, their difficulties and abilities.

Based on the arguments above, teaching is much more than just talking to the students as it involves analysing the problems that they have. Mentors need to

expose pre-service teachers to the analysis of positive and negative experiences in the classroom in order to understand the learners (Supovitz *et al.,* 2013). It is therefore not enough to give a nod to the correct answer and end without analysing why and how the students got their answers. Teaching practice is a time when pre-service teachers learn to inquire into their practices and, with the assistance of the mentor, understand the reasons for the practices (Kiggundu & Nayimuli, 2009).

Feiman-Nemser and Buchmann (1983) documented the pitfalls of experience in teacher preparation and demonstrated a scenario of the field experiences of three pre-service teachers under the supervision of their cooperating teachers. Two of these students believed that they had acquired enough knowledge to be teachers during teaching practice but one was not sure whether his experience was sufficient to make him a fully qualified teacher. Feiman-Nemser and Buchmann (1983) report that premature conclusions can mislead prospective teachers into believing that they have mastered all the teaching skills during teaching practice, calling them "pitfalls" which arrest the thought of future teachers. From my experience as a lecturer, I believe this to be true because most students think that they have achieved the goal after teaching practice.

2.6.3 Models of teaching

According to Steinbring (1998) and Simon (1997), a teacher's subject matter knowledge and knowledge of learners determines the tasks assigned to the students, the learning setting, learning process perception and the adjustment of the initial plans to suit reality. Depending on the models of understanding mathematics, some models of teaching were developed to match students' understanding. Leikin and Levav-Waynberg (2009) thus identified the cyclic models of teaching as follows:

(i)   Steinbring's (1998) model
In Steinbring's model, the teachers use the content knowledge they possess and their knowledge of the students to design tasks for the students. The students then use their knowledge to interpret the given tasks. The role of the teacher is to provide a more conducive environment for the students to approach the tasks, reflect on them and then construct their own knowledge of mathematics autonomously. The teacher observes the learning process, adjusting the tasks according to the needs of

the class.

(ii)   Simon's (1997) model of teaching

This is a cyclic model of teaching in which the role of the teacher is to design a learning trajectory that includes learning objectives, plans, the learning process and activities (tasks) and ensures that they are followed. The trajectory is based on the various types of knowledge teachers have but adjustments can be made during the process of interacting with students, which creates new ideas for subsequent lessons.

The cyclic models include lesson planning (goals), choosing instructional tasks and teachers' interaction with the students (Leikin & Zazkis, 2010). The teachers' role in the two models is to adapt the planned learning trajectory and to be aware of the mathematical understanding required (Leikin & Levav-Waynberg, 2009). According to Leikin and Zazkis (2010), the view of these two models is that teaching practice has a great potential for generating teachers' "learning to teach" experiences, while dismissing the idea that it is the sole composition of teacher knowledge. The two models thus develop the teachers' knowledge during the process of planning, working on the students' tasks and interacting with the students. During active participation of the teacher and the students, meanings are constructed and norms and practices are formulated (Barnard & Torres-Guzman, 2008; Zevenbergen, Mousley & Sullivan, 2004) in the daily mathematics classroom activities during "learning to teach"; creating a warm relationship between the teacher and the students. The intention of most lessons is that students learn by design and pre-service teachers, while supporting the learning also unintentionally learn from this (Leikin & Zazkis, 2010).

McDiarmid and Ball (1988) reveal that other researchers insist that pre-service teachers should know and inculcate the values, normative social behaviours and preferred common styles of the pupils they teach. This puts the pre-service teachers in a position to assist their pupils because emotions can affect the cognitive process of learning and the motivation of learners (Fried, 2011). For example, when a pupil is stressed, the major part of the brain shuts down and reverts to survival needs such as defensiveness and attention seeking (Fried, 2011). This may become a challenge

in the classroom.

Despite different views about the mathematics knowledge needed by pre-service teachers, McDiarmid and Ball (1988) contend that researchers agree that pre-service teachers cannot teach what they do not know. It is therefore essential that pre-service teachers be acquainted with the content knowledge of the mathematics they will teach in a way that they are able to deliver it to the pupils.

The study on teacher education and learning to teach (TELT) focuses on learning to teach academic subject matter to different learners. Borko *et al.* (2000) allude to several studies that have suggested that teachers with good subject matter knowledge and skills emphasise conceptual problem solving and enquiry aspects compared to pre-service teachers with less content knowledge. Those with less content knowledge, Borko *et al.* (2000) argue, emphasise facts, rules and procedures. Shulman (1987) also advised that instructional programmes in mathematics should focus on learning to reason and to construct proofs as part of mathematics understanding. Pre-service teachers therefore need to be able to investigate conjectures, develop and evaluate mathematical arguments and select different types of reasoning for successful mathematics teaching.

McDiarmid and Ball (1988) identified examples of subject matter knowledge of which pre-service teachers need to be aware. They suggested that "substantive knowledge" of the field of mathematics should include concepts such as areas and perimeters of shapes as well as knowledge of the school curriculum. These are actual concepts that pupils learn according to the school syllabus. They also identified "knowledge of the syntax" which involves testing the viability of a conjecture. For example, "the sum of the interior angles of a triangle is 180^{0}" is a conjecture. In presenting the solution to the proof of this conjecture, students should be aware of, for example, when to put a deduction or implication arrow in the process. Regardless of the acquired subject matter knowledge, Ball *et al.* (2005) emphasise that pre-service teachers need to connect the mathematics they have with the mathematics they will teach.

2.6.4 Challenges during teaching practice

During teaching practice, pre-service teachers face personal challenges and those associated with teaching, which affect their performance during practice (Hamaidi *et al.,* 2014). Studies by Al-Ajez and Hallas (2011) and Manzar-Abbas and Lu (2013) reveal that there is a lack of support for pre-service teachers from the school administration and teacher educators (college and school-based), a lack of motivation and a lack of educational materials such as textbooks. Manzar-Abbas and Lu (2013) established that pre-service teachers' challenges are based on three issues:

(i)   Duration of teaching practice: It is alleged that some pre-service teachers undergo teaching practice for a very short time, thus teacher educators do not have enough time with the pre-service teachers to understand their needs. In this regard, pre-service teachers do not receive enough assistance on the procedures to follow during teaching practice or get an explanation of the required skills. Conway (2002) suggests that teaching practice must be lengthened from one semester to one year for those universities that offer shorter periods for teaching practice.

(ii) Timing: The time at which pre-service teachers are sent for teaching practice may not be appropriate. For example, if pre-service teachers are deployed into schools during the time when students are writing their public examinations, they will not have enough time with the students. According to Kiggundu and Nayimuli (2009), during this time, most teachers are busy preparing their students for end of year examinations and may not be willing to expose them to pre-service teachers especially if the teaching practice is only for one term. Teaching practice therefore needs to be shifted in a way that more contact time with the students is available to the pre-service teachers.

(iii) Methods of practicum: Manzar-Abbas and Lu (2013) allege that some methods of teaching are out-dated and are not consistent with the current school curriculum. This may be because some teacher educators' strategies of teaching remain unchanged from the way they were taught in the past and this is passed on to the pre-service teachers.

One of the problems in teaching, according to Waghorn and Stevens (1996), is the gap between theoretical beliefs of pre-service teachers and their practical experiences in the classroom. Their experiences during teaching practice may force them to comply with the status quo in the classroom. This causes their theoretical knowledge acquired on campus and their prior beliefs and preconceptions about teaching and learning to become futile (Cavanagh & Prescott, 2007). It also prompts researchers to investigate the improvement of communication between theory and practice (Waghorn & Stevens, 1996). Waghorn and Stevens (1996) identify problems in teacher education that may hinder the effective application of theory during teaching. They confirm that there is lack of communication between educational research and teacher decision making which means that they are two different and independent bodies of knowledge. This causes the classroom teacher to make his/her own decisions without consulting what was researched and established as an appropriate way of teaching. The theories of teaching may thus be overlooked during teaching practice.

Contrary to their feeling that they could teach well during practicum, a study by Gan (2013) establish that some pre-service teachers were shocked by the work load they had during teaching practice and the challenges they faced from their mentors and college supervisors. Most of their time was spent with the assistance of the mentors, peer student teachers and the internet, designing tasks to be given to the students. The study brings out another problem of classroom management, especially when dealing with misbehaviour. The pre-service teachers realised that there was a vast difference between what they were taught and what they were experiencing on the ground. The problems of discipline in the classroom caused pre-service teachers to invest considerably in disciplinary issues instead of concentrating on pedagogical issues of teaching.

Gan (2013) also asserts that mentors are not always approachable when pre-service teachers turn to them for advice on discipline or classroom management causing pre-service teachers to feel isolated. In addition, school officials gave the pre-service teachers offices away from other staff members making it difficult to get assistance from experienced teachers. Because of such experiences, pre-service teachers' enthusiasm diminishes and their conceptions change as they face reality (Yilmaz &

Sahin, 2011). In this regard, their enthusiasm for teaching may dissolve into complaints. Consequently, because they want to avoid disapproval from their mentors, pre-service teachers may adopt the mentors' styles of teaching even though they conflict with the theory taught in college. When experiences are sour, pre-service teachers are likely to generate survival skills where they only use effective and task-based teaching strategies when they are being observed by their college supervisors in order to score a higher grade but centre their everyday activities on teacher-centred approaches, book-based or examination-oriented teaching strategies that they learnt during their school years (Gan, 2013). When this happens, it creates a gap between theory and practice and compromises researchers' efforts to apply corrective measures on the teaching of mathematics (Gan, 2013). Teacher educators (school and college based), as Gan (2013) suggests, should concentrate on disciplinary issues so that pre-service teachers only have to concentrate on the teaching of mathematics.

From a study conducted by Jusoh (2012), conflict was found to be the most challenging factor during teaching practice. This included conflict between theory and practice, expectations and reality, university supervisors and school supervisors and between policies and practice. Teacher training programmes therefore need to address these issues by focusing their gaze on designing programmes that build on pre-service teachers' pre-existing knowledge and beliefs in relation to their field practice (Feiman-Nemser, 2001). This could involve disposing of the pre-existing beliefs of teaching among pre-service teachers before replacing them with new ones. This way, learning may take place.

2.7 Structures, resources and tools to facilitate mathematics teaching during teaching practice

The main purpose of learning to teach is to improve the quality of education (Darling-Hammond, 2006) and classroom instruction (De Neve *et al.,* 2015). "Learning to teach" does not take place in a vacuum. The process of "learning to teach" is influenced by schools in which pre-service teachers practise (De Neve *et al.*, 2015). Pre-service teachers' experience in schools, on the job interactions and the identification of supportive antecedents change the pre-service teachers' pre-existing knowledge during training (De Neve *et al.,* 2015). Researchers agree that

professional learning leads to professionalism (Avalos, 2011) and it is usually long term, active and constructive. This section therefore investigates the main structures, tools and resources that foster professional growth of pre-service teachers as part of "learning to teach".

2.7.1 Structures: Pre-service teachers' experiences with mentors

Even though pre-service teachers are taught about the application of theory in teaching before teaching practice, the implementation of theory may be cumbersome as pre-service teachers experience unpredictable challenges during teaching practice. "Learning to teach" during teaching practice may therefore be achieved by assigning mentors to pre-service teachers. According to Cavanagh and Prescott (2007), Farrell (2008) and Kelly and Tannehill (2012), mentors are influential in shaping pre-service teachers' styles of teaching because they spend more time with them. The duties of mentors therefore, according to Kelly and Tannehill (2012), are to provide guidance and assistance as well as to foster habits and skills that enable pre-service teachers to recognise who they are in the profession and succeed as teachers. Mentoring also enables pre-service teachers to confront difficult situations during teaching practice and develop an understanding of students' knowledge and the manner in which they learn (Soylemez & Tuga, 2014). According to Kelly and Tannehill (2012), mentors do not just give assistance on how to understand the teaching of mathematics but also provide emotional support for the pre-service teachers. However, one would wonder whether the ideas raised above are workable in the real world of the classroom or remain as the intended goal of mentoring without action. Kiggundu and Nayimuli (2009) and Maphosa *et al.* (2007) reveal this as in their studies they ascertain that while some mentors fulfilled their roles of guiding pre-service teachers, some considered them as relief teachers who ended up taking full loads without guidance. In this respect, Soylemez and Tuga (2014) concur that the definitions of mentoring and the actual practices differ. If this practice is not monitored and the researchers' efforts to enrich teaching practice do not translate to performance, then the purpose of teaching practice may be subverted.

Feiman-Nemser (2001) established that mentoring does not only involve pre-service teachers copying the mentor but it also involves finding their own ways of teaching.

The mentor thus informs, suggests and makes recommendations regarding teaching (Maphosa *et al.,* 2007). Furthermore, mentors demonstrate skills as tools for "learning to teach" and this assists the pre-service teachers to visualise how they can incorporate these skills into their teaching (Kelly & Tannehill, 2012). However, Cavanagh and Prescott (2007) point out that pre-service teachers' innovative ways of teaching could be constrained by the way mentors want them to teach. Since they want good reports at the end of the practice, they tend to conform to what the mentors dictate to them.

One issue emphasised for pre-service teachers is that of practice. Kiggundu and Nayimuli (2009) state that it is difficult to train pre-service teachers without practice because pre-service teachers need exposure to various experiences in order to be fully acquainted with the knowledge of teaching. They add that problems during teaching are unpredictable and unique and therefore pre-service teachers require mentors to direct them during teaching practice. Ball et al. (2008) confirm this as they state that theory without practise is futile.

Feiman-Nemser (2001) contends that problems faced by pre-service teachers on teaching practice are normally constructed rather than given. For example, problems may be created because of lack of content on the teachers' part, inadequate work and a lack of instructions or unsuitable tasks given to the students. The mentor therefore works together with the mentee to pinpoint and establish the root of the experienced problems. Hamaidi *et al.* (2014) state that very little is known about the nature of assistance pre-service teachers get from their mentors but if pre-service teachers' needs are understood and met, it may improve the result of the practicum.

Kelly and Tannehill (2012) are critical of mentors who lack professionalism and expertise to supervise or guide pre-service teachers on teaching practices. Kiggundu and Nayimuli (2009) and Maphosa *et al.*'s studies (2007) support this, as they reveal that some mentors do not actually assess or guide pre-service teachers. Instead, they leave the classes in the hands of the pre-service teacher. This conflicts with the prescribed roles of the mentor as described by Holloway (2001). Maphosa *et al.* (2007) also establish in their study that some mentors treat pre-service teachers as relief teachers. This has a negative effect on the pre-service teachers' performance

and impedes the entire process of teacher training. The motivating factor behind such behaviour by mentors, as perceived by Hollins *et al.* (2014) and Kelly and Tannehill (2012), is that some teacher educators (school based), are appointed on traditional standards that requires no other additional formal preparation except classroom experience. It shows that whilst teaching experience is crucial and necessary to be a mentor, it may be inadequate. As a result, formal mentor training is necessary. In addition, Hollins *et al.* (2014) claim that there is an assumption that if a teacher (mentor) is good at teaching secondary school mathematics then automatically s/he will be good at the teaching of pre-service teachers. The assignment of roles of mentorship to teachers without formal training may downplay the significance of teaching practice in teacher education since their mentoring will be based on trial and error. Studies by Kelly and Tannehill (2012) thus found that several years of teaching experience without formal preparation might not prepare mentors to guide pre-service teachers during "learning to teach".

Kiggundu and Nayimuli (2009) specify that some mentors did not trust their mentees especially during the time of writing end-of-year examinations. As a result, they were not willing to relinquish their classes to pre-service teachers, thereby defeating the purpose of teaching practice. Consequently, this may cause pre-service teachers to get disheartened, discouraged, lack confidence and feel out of place. Kiggundu and Nayimuli (2009) concur with Evans, Jones and Dawson (2014) and Peake (2006) that mentors need to be qualified to train or supervise pre-service teachers. The studies conducted by Arnold (2006) and Kelly and Tannehill (2012) further found that mentoring is not an extension of being a teacher. This explains how crucial formal mentoring training is; thus, universities and teachers' colleges need to be vigilant and selective in terms of the schools they send their pre-service teachers to for practice and based on how the respective mentors are privy to the formal demands of mentoring.

Ganser *et al.* (1998) also raised the absence of the training for new mentors. From a survey that Brock and Grady (1998) conducted, 71% of the school heads offered no formal training programmes for mentors. Formal preparation of mentors is therefore fundamental in teacher education and should be ensured by schools and universities because mentoring is pivotal to the quality of pre-service teacher preparation

(Hudson & Hudson, 2010). In addition, Ganser *et al.* (1998) emphasised and recommended uniform mentoring, which can be achieved by collaborative work between schools and universities.

According to Hollins *et al.* (2014), the chain of teacher preparation is as follows: teaching competence is influenced by the quality of teacher preparation and teaching competence influences the quality of learning opportunities for students. The quality of learning opportunities for students determines learning outcomes. This implies that significant improvement in academic performance in schools for learners is unlikely to take place without significant improvement in teacher preparation, which relies on the preparation of teacher educators. It is therefore advisable that universities and teachers' colleges work in collaboration with practising schools by specifying the attributes of the mentors they expect to assist pre-service teachers. They would ideally interview the prospective mentors to check if they qualify. In the same vein, Hamaidi *et al.* (2014) also suggest that mini trainings, meetings or workshops for teacher educators (college and school-based) be conducted so that they are aware of what is expected of them to train pre-service teachers.

Just as mentors need to be familiar with the mentees' stages of development, it is important to be aware of the mentors' stages of development so that teacher educators or researchers understand how the stages affect pre-service teachers' performance on teaching practice. The language that mentors use to describe their work normally reveals the stages of development (Hollins *et al.,* 2014). From the above sentiments, (Hollins *et al.,* 2014) five stages of development are identified through which mentors pass in their growth as teacher educators. The stages are discussed below.

(i)   Pre-disposition
This is a stage when the qualified classroom teacher has been successful in his/her career as a teacher and is now seeking professional growth by being a mentor. S/he has the desire to assist and nurture others as an experienced teacher (Hollins *et al.*, 2014).

(ii)   Disequilibrium
From the pre-disposition stage, the teacher enters a period of fear, doubt and

reduced self-confidence. This is because s/he has moved from an environment where s/he was successful to a different and unfamiliar situation.

(iii)   Transition

It is sometimes described as the "quiet" stage. At this stage, mentors accept the fact that they are novice "adult educators". They sharpen their focus on the language and skills required to mentor pre-service teachers successfully. When they successfully apply the acquired knowledge and skills, they reach the confidence stage.

(iv)   Confidence

At this stage, the mentor does his/her work with confidence.

(v)   Efficacy

This is when mentors become sure-footed in their job and start to experience a feeling of pride in their achievement.

In addition to the stages of growth, a study by Hollins *et al.* (2014) identifies four positions of novice mentors according to the attributes they possess in relation to the approaches used in facilitating teacher learning:

(i)   The advanced novice teacher educator (school-based)

This type of a novice mentor is known to have the academic knowledge of the subject and the skills to teach it. S/he knows his/her limitations of experience and is self-motivated to consult textbooks and colleagues; s/he reflects on his/her work and then takes corrective measures to improve his/her practice.

(ii)   Aware novice

This type of mentor is aware that more knowledge and formal preparation is required to be a teacher educator but does not put in an effort to consult colleagues and relevant literature. S/he believes that if s/he is a good teacher at secondary level, then s/he can qualify to be a mentor. S/he usually learns through experience and implements what is already in place. Sometimes s/he realises that the strategies s/he uses to guide pre-service teachers are wrong but s/he does not take any action.

(iii)   Naive novice

The mentor in this position is confident in his/her work as a teacher but is not aware of the complexity of the role of a mentor. S/he does not consult sources of knowledge and, even if things go wrong during mentoring, s/he does not take any

action and tends to blame others. In fact, this mentor is not confident enough to interact with pre-service teachers, implying that s/he is not ready to be a mentor.

(iv)   Estranged practitioner

This kind of novice mentor lacks confidence as a teacher and is not prepared to become a teacher educator. S/he cannot develop a plan to facilitate "learning to teach". S/he tends to blame others for failing to provide procedures to guide pre-service teachers. It is therefore necessary to identify such teachers before pre-service teachers are deployed for teaching practice so that they are not engaged in the system of mentorship.

De Neve *et al.* (2015) examines the resources that foster the effective learning of mathematics and mathematics teaching. In their study, they identified job resources and personal resources. Under job resources, Bakker and Demerouti (2007) mentioned teacher autonomy and collegial support as the favourable contexts for teacher learning.

2.7.2 Resources

1.   Job resources

(a)   Teacher autonomy

According to De Neve *et al.* (2015), teacher autonomy refers to the freedom pre-service teachers have to determine what takes place in the classroom. For example, the selection of own teaching methods, strategies and assessment activities, planning the use of time in the classroom and choosing students' goals (Varatharaj, Abdullah & Ismail, 2015), illustrates teacher autonomy. This kind of autonomy is positively related to "learning to teach" and hence stimulates teacher performance (Bakker & Bal, 2010).

If pre-service teachers are given such independence in the classroom, it enhances their feelings of personal control (Pearson & Hall, 1993). This gives pre-service teachers the feeling of "owning" the learning process and the work environment. The student teacher has the feeling that s/he is accountable for every activity that takes place in the classroom. De Neve *et al.* (2015) contend that by giving pre-service teachers the opportunity to choose their own learning path, they experience more

ownership of their learning and practice. In their adventure, they are likely to come out with innovations in their teaching. In De Neve *et al.* (2015), it is posited that the more teachers are autonomous, the more they want to change and sustain the change. Martin (1998) supports this as he states that some mentors, who are too prescriptive of pre-service teachers, do not give pre-service teachers freedom to experience trial and error. Palsdottir *et al.* (2008) therefore recommend that pre-service teachers should be given opportunities to develop tools for teaching by learning to research their own practices. This enhances pre-service teachers' commitment to teaching and "learning to teach".

(b)   Collegial support/ professional learning communities' (PLC) characteristics

In the previous discussion, it was stated that autonomy plays a role in "learning to teach". Because this occurs in a school community, as confirmed by The American Mathematical Society (2012) and the Ministry of Education, Government of Guyana (2015), the school, the support and the resources that are available influence the pre-service teachers' learning. In this regard, De Neve *et al.* (2015) assert that schools can therefore be referred to as professional learning communities (PLCs), which imply the following characteristics:

(i) Deprivatised practice

This is when pre-service teachers trade off roles of mentorship, advisory roles and specialist roles among themselves. They use such instruments as peer coaching, joint planning and mutual observation. In each case, they give each other feedback and share ideas for better classroom practices. Through these collegial relationships, pre-service teachers become more conscious of the influence of pre-existing beliefs and expectations about teaching practice.

(ii) Reflective dialogue

This is when pre-service teachers reflect on their own classroom practices and discuss classroom practices with colleagues. The sharing of ideas will initiate changes in educational practices (Newmann & Wehlage, 1995; Stoll *et al.,* 2006).

(iii) Collective responsibility

Collective responsibility refers to discussion among pre-service teachers

regarding instructional methods for particular topics. These will boost students' intellectual growth (Stoll *et al.,* 2006; Wahlstrom & Louis 2008). This system also benefits those pre-service teachers who are isolated. They are co-opted into the system, consciously or unconsciously and hence gain from the shared ideas. Francis-Seton (2011) support this as they emphasise that since teaching is a complicated profession and it is challenging to meet all the demands in teacher education, pre-service teachers need to share their experiences with others in order to develop their professional identity.

2.   Personal resources

De Neve *et al.* (2015) suggest that self-efficacy is a good example of personal resources because it reflects how confident learners are in performing certain tasks. It reduces alienation of learners because it signifies a sense of engagement and a positive regard for work (Gosnell, 2012). It thus assists learners to overcome obstacles. Many studies have shown that self-efficacy is a resource that is essential for teachers to develop professionally because it affects choices of activities and shows how people persevere when confronted with problems (Bandura, 1997). A teacher who possesses self-efficacy can easily change his/her instructional strategies to suit the students' abilities because s/he is self-driven to teach. The innate desire in the teacher compels him/her to give remedial work and extra instruction to disadvantaged students. Wertheim and Leyser (2002) confirm this in their study with Israeli pre-service teachers.

Mokhele and Jita (2010) advocate for continuing professional development (CPD) programmes that they view as systematic efforts to bring about change in the way teachers work in the classroom, change in teachers' beliefs and attitudes as well as change in the students' learning outcomes. Consistent with this idea, Ambrosetti (2014) and Taber (1998) also identify several programmes that were designed in teacher education to foster "learning to teach" mathematics. This shows that if such programmes are exposed to pre-service teachers during teaching practice, then they may become viable tools of "learning to teach" which, as a result, may enhance the effectiveness of teaching practice as part of teacher knowledge. Hiebert, Morris and Glass (2003) advise teacher educators that pre-service teachers need to experience

a learning environment that they can create in their own classrooms during teaching practice. This means teacher educators and teaching theory must expose pre-service teachers to environments that they (teacher educators) expect to see when they visit pre-service teachers for supervision during teaching practice. Teacher preparatory programmes should therefore assist pre-service teachers to acquire the tools that they will use during teaching practice instead of giving them "finished competencies" of effective teaching. One of the programmes identified is the Cognitively Guided Instruction (CGI) in which teachers participate in the development of children's mathematical knowledge. During "learning to teach", CGI can be used as a tool that informs the learning and teaching of mathematics. CGI focuses on the development of children's mathematical thinking (Carpenter, Fennema & Franke, 1996). Drawing on the study conducted by Franke and Kazemi (2001), CGI encourages pre-service teachers to be learners rather than teachers by listening to the learners who are given ample time to explain their thinking. In this way, students learn with understanding and have ownership of the knowledge they possess. This enables them to apply and implement what they learnt to real life situations. CGI thus, becomes a tool that has the potential to end the belief among pre-service teachers that students are mere receivers of knowledge from the teacher.

Problem-centred mathematical instruction is another tool that pre-service teachers can utilise to enhance their performances. The Purdue Study proved and established this (Wood & Sellers, 1996). This method is anchored on constructivism and is based on the belief that students effectively learn mathematics if they construct mathematical meaning on their own rather than just receiving knowledge from the teacher. It also involves an extensive interaction between the teacher and the students, with students spending most of their time working on problems (Wood & Sellers, 1996). By doing this, pre-service teachers develop effective skills of communicating knowledge to the students and improve their expertise in teaching mathematics.

"Teaching to the Big Ideas" (TBI), as affirmed by Randall and Carmel (2005), is a study that was conducted for teachers to develop their knowledge of mathematics and to find out how teachers' mathematics understanding affects their teaching. This

study was meant to address mathematical ideas that emerge in the classroom as students air their views during teaching, thus promoting students' autonomy. By involving themselves in such essential projects as mentioned above, pre-service teachers may benefit during teaching practice.

3. Textbooks

Harrison (2003) reports on how teaching resources may be critical to the process of teaching and Nicol and Crespo (2003) specifically pinpoint the textbook as a tool to facilitate teaching. However, they condemn the continuous use of and tendency to follow the textbook verbatim, which they say obstructs effective "learning to teach". Nicol and Crespo (2003) encourage the use of innovative curriculum materials by pre-service teachers and their mentors so that they are able to interpret students' thinking and can design student tasks based on the curriculum. Based on the study conducted by Remillard (2009), pre-service teachers' practice of teaching changed, not only because of the use of other curriculum material but also because of their effort to understand students' work in textbooks.

The debate continues with studies by Ball *et al.* (2001) and Feiman-Nemser and Buchmann (1983) showing that most pre-service teachers normally prefer to use their own views and ideas about subject matter knowledge and pedagogy rather than the textbook. They assumed that using the textbook only is not professional. Whilst the textbook is a tool for "learning to teach", pre-service teachers do not have to depend on it alone as a teaching resource.

According to Haser (2010), the school and classroom contexts in addition to personal preferences of pre-service teachers are among the determinants of mathematics teaching and learning among pre-service teachers. For example, if administrative procedures of the school (school bureaucracy) are excessively complicated, pre-service teachers' performance of their duties will be affected. Resources may fail to reach the classroom or student teachers may fail to get the support they need from the school.

2.8 Differences between the pre-service teachers' expectations and their experiences during teaching practice

According to Cole and Knowles (1993), Sag (2014) and Weinstein (1988), many pre-service teachers are shocked when they discover that their expectations of the schools, students and mentors they meet during teaching practice are completely divorced from reality. They assert that the discrepancy is normally caused by the pre-service teachers' perception that the students they will teach are similar to what they were during their time as students. Hence, these distorted perspectives about teaching and learning have some bearing on the gap between expectations and realities.

Sanger and Osguthorpe (2010) match the relationship between beliefs, expectations and actions. They questioned whether changes in beliefs mean changes in teaching practice. Martin (1998) and Zeichner and Liston (1987) hence argue that learning from field experiences is not without problems. Similarly, Richardson-Koehler (1987) also made the point that the problems faced by pre-service teachers, mentors and college supervisors limit the experience of reality. These research findings on the challenges of teaching practice echo the sentiments by Ferman-Nemser (2001) and Cole and Knowles (1993) who agree that there seems to be a mismatch between pre-service teachers' college learning and their expectations, especially in the field. This suggests that the theoretical teachings that pre-service teachers acquire in college might not suffice in terms of the implementation of skills in the classroom.

Building on the view by Cole and Knowles (1993), most pre-service teachers view teaching practice as easy to accomplish but when they realise that it is not so, their hopes are often shattered and their accounts of the experiences of teaching practice become negative. Contrary to their expectations, Haser (2010) posits that pre-service teachers experience situations where the structure of the educational system affects their teaching. For example, the level of state control over the national or local curriculum influences teaching and learning as well as school activities. Some mentors, because of a lack of time, would not let pre-service teachers teach and some pre-service teachers teach the same topics at the same time to students of different abilities because the syllabus needs to be covered before the end of the year (Kiggundu & Nayimuli, 2009).

In his study on "learning to teach", Haser (2010) reveals unexpected problems pre-service teachers experience during practice. Pre-service teachers expect that college supervisors would observe them while interacting with the learners but they are normally taken aback when supervisors focus more on paperwork, lesson plans, timetables and schemes of work giving little attention to actual teaching. According to Haser (2010), most pre-service teachers complain that college supervisors allocate them a mark for a whole year from a single 15 to 30 minute lesson, which does not reflect their actual performances. In the same study, it was discovered that pre-service teachers' expectations to cognitively change the pupils' behaviour sometimes does not materialise when they take over classes that were being taught by others. The pupils' behaviour becomes difficult to change because of their experiences with the previous teacher.

Before going on teaching practice, pre-service teachers expect to practise in a warm, caring, understanding, loving environment where they will be able to relate well to their pupils. Teaching is seen by most of them as a simple transfer of information to pupils and is based on the teacher and the textbook, without considering unpredictable challenges from the school environment. They become disheartened when they realise that their expectations do not conform to reality. The major problem usually emanates from how teacher knowledge on campus can be transferred to practice (Allen & Peach, 2007). Normally when pre-service teachers find themselves experiencing frustration, anger and bewilderment, they react by placing the blame on the college for their inadequate preparation. This suggests that the theoretical knowledge acquired in colleges needs to be taught in such a way that the pre-service teachers can easily translate it into actionable sequences in the classroom. However, Vesilind and Jones (1998) argue that the knowledge taught on campus is fluid and sensitive to how pre-service teachers' beliefs can be reconstructed.

Studies by Barry and Lechner (1995) have shown that most pre-service teachers look forward to being able to take multicultural classes during TP but seem to lose confidence in real classroom situations. This shows the conflict that exists between pre-service teachers' expectations and reality. Weinstein (1988, p. 31) calls this conflict "unrealistic optimism".

After consulting former pre-service teachers, Nahal (2009) concurs with Cole and Knowles (1993) that pre-service teachers' expectations do not match their field experiences. They reveal that high expectations can make pre-service teachers' disillusioned, lose hope and discouraged. This means that pre-service teachers' failure to realise their expectations defeats their purpose of teaching. To this end, Feiman-Nemser (2001) explain that the world of thought is divorced from the world of action. However, understanding and action complement each other and neither understanding nor action by itself will suffice (Ferman-Nemser, 2001). This implies that the theoretical knowledge of teaching alone that students acquire in college does not necessarily give the ability to teach if it is not put into practice.

From a number of studies that were conducted concerning teacher knowledge, Ball *et al.* (2001) argue that some of the findings are not valid because teachers are interviewed and questionnaires are distributed without observing actual teaching. Ball *et al.* (2001) thus posit that being able to talk about mathematics is different from doing it and that most researchers describe teachers' knowledge in terms of what they know about teaching and not actual teaching. This study therefore analyses pre-service teachers' teaching practice in addition to the mathematics content knowledge (MCK), pedagogical content knowledge (PCK) and the curriculum knowledge they are exposed to because it is not only what they know that matters but how to implement and practise it.

Santagata *et al.* (2007) assert that pre-service teachers on teaching practice believe that experienced teachers do the right thing all the time. This encourages them to imitate what they do even though experienced teachers may have their own weaknesses (Kennedy, 1999). This can shape pre-service teachers' understanding of mathematics teaching in a way that conflicts with the demands of teaching practice. For example, a pre-service teacher may imitate a teaching strategy that does not comply with the students' needs. Once the students get frustrated, Fried (2011) observes that they may decide to shut down their minds so that they do not hear anything. In this regard, teaching practice may cease to guarantee effectiveness. Ball *et al.* (2001) also argue that what students learn in colleges fail to change what was ingrained in the teachers through observing other teachers, confirming the idea that mathematics teaching is normally dictated by what pre-

service teachers have experienced. Smith (1991) hence notes that university-based and school-based portions of pre-service preparation should be consistent with and affirmed by one another so that the issue of mentoring becomes clear.

When pre-service teachers' beliefs conflict with what they are taught and their expectations are not realised, they sense a gap and ultimately personal experiences and beliefs subsume book knowledge (Eisenhardt *et al.,* 2012). This suggests that when they realise that their beliefs are dysfunctional, their hopes and images may become disabled and they begin to focus on survival skills whereby they apply their own experiences to succeed. Specifically because of these teaching experiences, they may not see "teaching" as a career but as a prescription.

Ambrose (2004), Evans (2011), Hill *et al.* (2008), Kajander (2005), Norton (2010) and Tsao (2005) illustrate that most pre-service teachers' lack confidence in the content knowledge they teach. Bekdemir (2010) supports this, noting that most pre-service teachers have the problem of mathematics anxiety, which can be transferred to the learners. Bekdemir (2010) states that this anxiety is linked to their prior experiences of instruction, which is likely to lower their confidence and motivation during practice.

2.9   Other researchers' views on how to improve the experiences of teaching practice during "learning to teach" mathematics

Despite several arguments on teacher knowledge, the effect of the proposed solutions by different researchers on students' achievement has not been proven (Ball *et al.*, 2005). These researchers therefore propose programmes that link teacher preparation and knowledge to students' achievements using mathematical knowledge for teaching (MKT). This knowledge can prepare a teacher who is able to make information accessible to the students, resulting in student achievement. However, Ball *et al.* (2005) assert that while mathematics knowledge for teaching cannot overcome the current achievement gap, it can prevent the gap from growing bigger.

Despite the fixed curricula in schools, a study by Eisenhardt *et al.* (2012) reveal that pre-service teachers need to be aware that students are different and therefore need

to be treated differently. Because learners have personal, social and emotional needs that have an impact on learning, they may need individual attention.

Even though pre-service teachers' beliefs are difficult and slow to change (Yilmaz & Sahim, 2011); Lee (2003) and Wideen *et al.* (1998) recommend that a more productive approach in "learning to teach" could be devised. Wideen *et al.* (1998) suggest that instead of focusing their research on what pre-service teachers need to know about mathematics and how they can be trained to do it, researchers need to embark on identifying what pre-service teachers already know, how they obtained that knowledge and how it can be reshaped if need be. Chan and Elliot (2004), Nespor (1987) and Yilmaz and Sahim (2011) concur with this opinion and acknowledge that change is impossible if the current beliefs about teaching are not disposed of first. Knowing pre-service teachers' beliefs and conceptions about teaching and learning is thus essential for changing them accordingly before replacing them with the intended ones. Fermann-Nemser (2001) and Leke-ateh, Assan and Debeila (2013) thus propose that designing programmes that build on the pre-service teachers' pre-existing beliefs can be an alternative to changing those beliefs even though Stofflet and Stoddart (1994) argue that pre-service teachers do not change their beliefs but they become more skilful in defending them. Pre-service teachers are also encouraged to examine their own beliefs as a first step in learning to teach and then to reflect on those beliefs to establish their relevance during practice (Fermann-Nemser*,* 2001). Wideen *et al.* (1998) support this, suggesting that "learning to teach" is a personal activity and pre-service teachers therefore need to deal with their own prior beliefs about teaching. The assumption being implied is that an alteration in prior beliefs, expectations and preconceptions will change the practicum.

2.10 Summary of the chapter

This chapter reviews the literature on pre-service teachers' field experiences during the process of "learning to teach". The main purpose was to establish other researchers' findings on pre-service teachers' beliefs, expectations, dispositions about mathematics teaching and experiences during teaching practice. It also investigated mathematics teacher knowledge that is suitable for pre-service teachers

in teacher preparatory programmes and how this knowledge affects pre-service teachers' performances during teaching practice.

The chapter deals with the conceptual framework which was based on "learning to teach", with reference to the theory on pedagogical content knowledge (PCK) by Shulman (1986). In this section, the concept "learning to teach" was defined and analysed to establish what "learning to teach" entails. The section hence focused on several concepts such as teaching practice, pre-service teachers' beliefs, expectations and concerns that are normally associated with the concept of "learning to teach".

The components of teacher knowledge were also reviewed. Although there are many components of mathematics teacher knowledge, these were limited to mathematics content knowledge, curriculum knowledge, pedagogical content knowledge, mathematics knowledge for teaching and field experiences. Each one of these was scrutinised to establish how it affects pre-service teachers' performance during "learning to teach" and particularly during teaching practice. The subsequent sections focus on the sources of teacher knowledge in order to assist teacher educators to appraise pre-service teachers on their strengths or explain their weaknesses.

The focus of the study was field experiences. This chapter therefore touched on the concerns and benefits of field experiences for the pre-service teacher as researchers reflect them. This included how theory can be merged with practice in the field. The review of the literature established that mathematics teaching is affected by factors that include pre-existing beliefs about the nature of mathematics, pre-conceived ideas and expectations about teaching (Frydaki & Mamoura, 2011). This section was followed by a review of the differences between pre-service teachers' beliefs and conceptions about mathematics teaching before and during teaching practice. During teaching practice, pre-service teachers' experiences may be different from their expectations and beliefs prior to teaching practice (Tarman, 2012). The chapter also focused on the experiences of teaching practice that included teaching styles and strategies, classroom management, experiences with other teacher educators and student teacher peers as well as challenges associated with these experiences.

The chapter concludes with suggestions and recommendations from several researchers on how teacher education programmes can improve teaching practice as part of "learning to teach". This includes insights into the subject matter content taught, subject pedagogy in preparation for teaching practice and what actually takes place on the ground during teaching practice. The next part of the study, chapter 3, presents the methodological approach used in the research.

CHAPTER 3

RESEARCH DESIGN AND RESEARCH METHODOLOGY

3.0 Introduction

In this study, I examined pre-service teachers' expectations, their beliefs before teaching practice and their mathematical knowledge and experiences during teaching practice. This chapter presents the methodological approach used in the research. It delineates a detailed design of the study and describes and justifies data used in the thesis (Bricki, 2007). The purpose of this chapter is therefore to highlight the approaches to data collection, the research paradigm, research design, target population, sampling methods, sampling procedures, research instruments, data analysis procedures and methods of ensuring validity and reliability of collected data. Justification of these selected approaches is explained in relation to the research objectives. The chapter describes variables to be tested and procedures used to collect data. To shed light on the researcher's study structure and methodological choices, an examination of the paradigm adopted for this study is presented before discussing specific methodologies employed in the study.

3.1 Research paradigm: Pragmatism

According to Cameron (2011) and Hall (2012), a paradigm is a way of perceiving the world. Because it is the paradigm that guides researchers' beliefs and feelings about the world and how it should be understood and studied, research is thus governed by particular paradigms (Denzin & Lincoln, 2011). Furthermore, paradigms direct and guide the way people think or act. Consistent with this definition, a paradigm, as described by Guba (1990), and Taylor, Kermode and Roberts (2007), is a belief system that guides the way we do things. Some examples of paradigms are positivism or constructivism. Paradigms can be defined or described by their ontology and epistemology (Guba, 1990). Ontology refers to what really exists and how the nature of reality can be viewed (Hudson & Ozanne, 1988). For example, knowledge can be viewed as existing "somewhere" as a law of nature, waiting to be ascertained. On the other hand, some may view knowledge as a social reality that can only become known through an individual's interpretation. Epistemology refers to the researchers' relationship with the knowledge they found (Carson *et al.*, 2001).

According to Carson *et al.* (2001), the researchers' views as to whether they are part of that knowledge or not, constructs and shapes the researchers' interaction with what they are researching. This, therefore, implies that the objectivity or subjectivity of the uncovered knowledge largely depends on the researcher's ontological or epistemological view. In view of this, ontology and epistemology breed a view of how people perceive knowledge and how they see themselves in relation to the discovered knowledge. This in turn affects the methodology used by the researcher in data collection, implying that various paradigms dictate certain methodologies of collecting data.

Paradigms are therefore crucial in this study because they provide lenses through which investigations of teacher knowledge are conducted (Weaver & Olson, 2006). Even though research on teacher knowledge is extensive, different researchers anchor their research on different paradigms; hence, they have different ways of interacting with and viewing the environment (Michel, 2008). As a result, research studies are conducted differently and results are likely to follow suit. Denzin and Lincoln (2011) thus contend that the researchers' beliefs and feelings about the world and the manner in which it should be understood and studied guide all research.

This study is underpinned by pragmatism. Whilst the quantitative approach is informed by the positivist paradigm and the qualitative approach is based on the constructivist or interpretive perspective, the mixed methods approach, which informs this study, is a product of the pragmatist paradigm (Cameron, 2011; Tashakkori & Teddlie, 2009). Pragmatism, based on its epistemology and ontology, is a belief that reality is realised through experience and observation (Terrell, 2012). I opted for this particular paradigm because it is an educational philosophy, which believes education should be practical, i.e. education should come through experience (Creswell *et al.*, 2013). Since the study has an interest and agenda to investigate and establish whether the reality of teacher knowledge can be realised by the degree to which it is useful in practice, it fits well into the tenets of pragmatism.

According to Cucu and Lenta (2014), the term pragmatism developed from the Greek word meaning; to do, to make or to accomplish. The terms that are commonly

associated with this paradigm, according to Cucu and Lenta (2014), are words such as action, activity or practice. This implies that pragmatists value action more than ideas. In agreement, Cameron (2011) asserts that pragmatism is a practical approach to a problem. This paves the way to the pragmatists' perspective about learning that beliefs and ideas only become true if they are workable, profitable and practically efficient, otherwise they are delusive. The pragmatist paradigm therefore informs this study which seeks to establish the relevance of pre-service teachers' beliefs and expectations on their practical work during teaching practice and the significance and contribution of teaching practice to teacher knowledge.

3.2   Research approach

A research approach, which may be used interchangeably with a research design, is defined by Creswell (2014) as orderly plans and procedures, which a researcher develops to study a problem. Based on this, it defines the research question, data collection, presentation, interpretation and analysis methods and tools (Denzin & Lincoln, 2011). A research approach thus provides a smooth run of different research procedures with minimal usage of time, effort and money (Denzin & Lincoln, 2011). In this study, the mixed methods approach was used to conduct the study.

3.2.1 Mixed methods

No single method met all the required aspects in this study. Therefore, the researcher found it necessary to use the mixed methods approach. According to Guba and Lincoln (2005), the paradigm choice guides and shapes a study. Since this study focused on a pragmatic paradigm, it necessitated methods of data collection that involved dialogue with the participants as the source of information. Hence, the researcher sharpened her focus on mixed methods to realise the nature and impact of teaching practice on teacher knowledge. The mixed methods approach involves investigating a problem using various data sources in a way that presents different perspectives about the question (Patton, 2002). Creswell *et al*. (2013), and Lincoln and Denzin (2011) define a mixed methods approach as a design for collecting, analysing and mixing the quantitative and qualitative data in a single study in order to understand a research problem. The mixed methods

approach uses different strategies to collect and analyse data rather than subscribing to one method (Creswell & Plano Clark, 2011). The various definitions given above reflect the mixing of two or more research methods to study a problem (Tashakkori & Teddlie, 2009). In mixed methods research, researchers gather numerical data, text information and various artefacts (Ivankova, 2014) and this allows the researcher to expand an understanding from one method of research to another (Lopez-Fernandez & Molina-Azorina, 2011). Tashakkori and Teddlie (2009) posit that even though this method has become popular in research, it requires researcher proficiency in qualitative and quantitative techniques. The researcher decided to use the mixed methods approach as the quantitative aspect dealt with the statistical analysis whilst the qualitative method dealt with emotional facts that influenced the study (Gilbert, 2001). The data collected by both approaches is normally integrated during interpretation (Creswell *et al.*, 2013). Cameron (2011) describes mixed methods as research in which the researcher collects, analyses, mixes and draws illations from quantitative and qualitative data in one study. In this study, the mixed method evaluation analysed the link between the nature of pre-service teachers' prior experiences and beliefs against their practical experiences in the teaching field and beliefs during teaching practice.

Creswell and Plano Clark (2011) and Lopez-Fernandez and Molina-Azorina (2011) have identified examples of cases where a mixed method approach is used. If the study problem seeks to ascertain and distinguish factors that shape an outcome and at the same time, there is little or no research about the subject of the study, then the quantitative and qualitative means of collecting and analysing data can be employed. In this study, my preliminary reading suggested that there is not much research on learning to teach secondary school mathematics from practice, particularly in Zimbabwe and the intention of this study was to identify the classroom behaviour of pre-service teachers that influence their performance and ultimately learners' achievement in mathematics. The mixed methods approach was thus deemed suitable for this study.

Since the mixed method approach incorporates the quantitative and qualitative approaches, it is necessary to explain in short what these approaches entail. A quantitative research approach is a systematic enquiry of an event that is observable

through statistical techniques (Aliaga & Gunderson, 2003). In line with this, Creswell (2014) contends that it incorporates strategies of enquiry that allow experiments, surveys and data collection on pre-determined instruments, which yield statistical data. As a stand-alone approach, it is usually based on a positivist perspective, which is the view that reality exists somewhere and is awaiting the researcher to use objective means/instruments to uncover it (Aliaga & Gunderson, 2003).

In a quantitative research, an experimental design is used to assess attitudes before and after an experiment (Creswell *et al.*, 2013). Even though this data (attitudes and beliefs) do not naturally appear in quantitative form, such data can be collected in a quantitative way (Aliaga & Gunderson, 2003). The study thus collected data on mentors' attitudes and experiences with pre-service teachers during teaching practice and on pre-service teachers' beliefs and expectations about teaching before and during field experiences using questionnaires. In a quantitative research study, the researcher analyses data with the assistance of statistics to achieve an unbiased result that can be generalised on a given population. The collected data in this study was analysed on a 5-point Likert scale using the SPSS programme where averages and standard deviations were calculated to analyse the data. Tables and bar charts were also drawn to present and analyse the collected data.

On the other hand, the qualitative approach, according to Michel (2008), shares its philosophical base with the interpretive paradigm. The interpretive view encompasses the perspective that multiple realities and truths exist "out there" which is determined by a person's perception of his/her environment (Michel, 2008). This is congruent with the focus of this study, which sought to establish the reality of the contribution of teaching practice to teacher knowledge as determined by pre-service teachers' beliefs, expectations, conceptions and preconceptions about mathematics and mathematics teaching.

Additionally, since the interpretive view is related to approaches that render the opportunity for the voice, concerns and practices of participants to be heard (Weaver & Olson, 2006), this study used focus group and semi-structured interviews to capture the concerns, anticipations, feelings and impressions of pre-service teachers and supervisors about mathematics teaching. The participants' responses to the

interviews may bring about and establish how teaching practice can be significant to teacher knowledge.

Qualitative research uses strategies of enquiry such as narratives. According to Creswell (2014), data gleaned from the qualitative approach is reported in words. Considering it as an isolated approach in a study, qualitative research is based on a constructivist perspective. In qualitative research, the participants' views and perceptions assist the researcher to establish the meaning of a phenomenon (Creswell *et al.,* 2013). The other key component of collecting data using this method is to observe participants' behaviour by participating in their activities. According to Creswell *et al.* (2013), the qualitative approach creates resonance and credibility with the subjects/participants in data collection and is informed by research instruments such as interviews, observations and document analyses. For this study, the researcher sought to examine the relationship between pre-service teachers' prior beliefs, expectations and experiences before and during teaching practice through interviews and the observation of such documents as study materials and syllabi.

In a qualitative research study, the researcher is the key instrument in data collection (Eisner, 1991; Fraenkel & Wallen, 2006; Guba & Lincoln, 2005; Merriam, 2009). In addition, Creswell *et al.* (2013) and Hancock (2002) posit that the focus of qualitative research is on the participants' perspectives, experiences and the ways in which they make sense of their lives. The study thus sought to establish how pre-service teachers valued themselves as teachers in the field by focusing on their perceptions and experiences about teaching before and during teaching practice.

Based on the above perspectives, the study was anchored on the belief that collecting data using various approaches (mixed methods) provides a comprehensive nature of the research problem. The results or findings from the qualitative approach thus agree with or refute the quantitative results, which enhances the validity and reliability of the study. Creswell *et al.* (2013) agrees that a mixed method approach converges or confirms findings from various data sources. Furthermore, the mixed methods approach has an advantage that the researcher is not restricted to one method of enquiry (Lopez-Fernandez & Molina-Azorina, 2011). The study thus incorporated interviews and questionnaires to ascertain the

trustworthiness of the data as data from both sources were compared. According to Creswell *et al.* (2013), a disadvantage of the mixed methods approach is that it is time intensive because it is an all-encompassing data collection and analysis of both text and numeric data. In addition, the researcher needs to be familiar with the quantitative and qualitative forms of research. To counter this weakness, the researcher was meticulous in collecting data and sought assistance from expert researchers on how these forms of research could be employed best.

Below is a summary of the research paradigm used in the study.

Table 3.1: Summary of the research paradigm in this study

	PRAGMATIST VIEW (Mixed methods)	
Characteristics	**Quantitative**	**Qualitative**
Purpose	The researcher administered questionnaires to pre-service teachers before and during teaching practice and to mentors to recognise the value and depth of individual subject content as well as to establish the effects or impact of pre-service teachers' prior beliefs, expectations and experiences on their performance.	The study interviewed pre-service teachers, supervisors (school and college based), to establish feelings and notions about mathematics and mathematics teaching. Document analysis as a follow-up to interviews and questionnaires
Belief	One truth exists, that is, there is a specific way of doing or teaching mathematics.	There are many truths and realities. Different people have different experiences, needs and perceptions, hence

Characteristics	PRAGMATIST VIEW (Mixed methods)	
	Quantitative	Qualitative
		different interpretations of knowledge. Knowledge is constructed and not discovered.
Research methods	Quantitative	Qualitative

3.3   Research design: Explanatory sequential

Although there are many research designs that inform the mixed methods approach, the explanatory sequential design was preferred for this study. The explanatory sequential design is when data collection and analysis using quantitative means precedes data collection and analysis by qualitative means (Ivankova, 2014; Terrell, 2012). In this study, data was collected using questionnaires first, followed by interviews so that qualitative data would be used to explain and interpret quantitative data. It is more useful if the quantitative approach provides unexpected data, which needs to be confirmed by qualitative means (Ivankova, 2014). By so doing, events, beliefs, attitudes or policies that shape the process of "learning to teach" mathematics are depicted (Marshall & Rossman, 2011). Additionally, Marshall and Rossman (2011) contend that the explanatory sequential design is simple to use because data is collected and analysed in stages to confirm whether qualitative data matches quantitative data.

The explanatory sequential design was deemed appropriate for this study because, after exploring the results of data collected in quantitative form, data could be clarified, adjusted or replenished through qualitative approaches to ensure the credibility and trustworthiness of the data (Terrell, 2012). For example, from questionnaire 3 (for mentors), question 39, "What do you like about pre-service teachers during teaching practice?" was asked and several responses were given. Some liked pre-service teachers so they were relieved of their duties and some liked

the obedience of pre-service teachers. The question required mentors to explain what they liked about the student teachers regarding their performances. However, this was clarified in the focus group interviews when the participants were asked to answer questions 10 and 12: "From your own assessment, what kind of knowledge are the pre-service teachers strong in?" (Question 10) and "What are the major successes that pre-service teachers experience during teaching practice, specify examples?" (Question 12). The discussions and probing by the researcher clarified what mentors admired about pre-service teachers regarding their content knowledge, performance and their relationship with the mentees. However, the explanatory design is time consuming, especially if the two approaches are given the same priority, as was done in this study (Creswell, 2013; Terrell, 2012). The researcher had to work against the grain to ensure that the approaches were applied on time.

3.4 Sample and sampling procedures

The study employed the purposive sampling method. According to Cohen *et al.* (2007), members of the population in purposive sampling do not have an equal opportunity of being picked for research. Random sampling was not possible due to the study design. Purposive sampling was therefore chosen to provide the research with the most useful data upon which to evaluate the contribution of teaching practice to teacher knowledge. With purposive sampling, members to be included are selected based on the researchers' judgement, which is determined by the attributes being sought (Cohen *et al.*, 2007). The purposive sampling in this study thus involved the researcher making a conscious decision about which pre-service teachers, mentors and colleges would best provide the desired information (Burns & Grove, 2007; De Vaus, 2002). The researcher required specific levels of pre-service teachers pursuing a specific programme in specific colleges. She thus wanted to deal with first year mathematics pre-service teachers and mathematics teacher educators (college and school-based). Two secondary teachers' colleges in Zimbabwe were considered because they had pre-service teachers in session, soon to go on TP. The researcher deliberately selected some members of the population to include in the sample, whilst purposively avoiding some members to focus on a particular group (Devers & Kelly, 2000). Mathematics school-based mentors were

selected from the districts in Harare, Mashonaland East and Bulawayo Metropolitan provinces because that was where most student teachers were deployed. No other attributes were looked at for the inclusion of these mentors in the study.

In purposive sampling, there are no stringently enforced rules about the sample size (Golafshani, 2003). In this regard, not all first year pre-service teachers were considered for this study. Only 120 first years were considered before going on TP. The figure constituted 75% of the population of 160 first year pre-service teachers. This number was thought to be a realistic expectation as it represented over 70% of the total number of pre-service teachers in each college. This was a suitable figure as confirmed by the Creative Research System (2014), which contends that 50% should be the worst acceptable case when determining the sample size. In addition, when using the sample size calculator for a population of 160, with the confidence level of 95% (common standard used by researchers) and margin of error being 4.5%, the sample size required is 120.

The researcher's reason for using purposive sampling is best depicted by Kumar (2014) who says that a researcher normally seeks those participants who, in his/her own opinion, have relevant information and are willing to share it. To this end, pre-service teachers who were ready to share their expectations and experiences about teaching were asked to answer questionnaires and were interviewed.

Purposive sampling was designed to understand participants' experiences in depth. In order to get rich data, the researcher deliberately chose cases where the most relevant and plentiful data could be obtained (Devers *et al.,* 2000; Yin, 2011). Hence, the selection of pre-service teachers from the two teachers' colleges was intentionally done. Mathematics pre-service teachers in their first year before TP were chosen because they gave the most appropriate sample based on the purpose of the investigation. According to Nicol and Crespo (2003), participants' backgrounds (prior experiences) normally influence their beliefs and expectations which, according to Russell and Russell (2014) and Johnson and Artwater (2014), play a significant role in pre-service teachers' performance. Thus, the mathematics pre-service teachers were sampled according to the areas (urban areas, peri-urban areas and remote rural areas) from which they were raised. Choosing pre-service

teachers at random could have caused a population from the same area to constitute the sample. It would then have been difficult to establish if their responses during interviews or questionnaires were consistent with their backgrounds. Demographic information, which included the high school attended by the pre-service teachers, was obtained first to provide a context for the pre-service teachers' backgrounds.

3.5   Research instruments

According to Leedy and Ormrod (2013), research instruments provide a basis on which the whole study effort rests. The study thus, employed three types of research instruments to collect data. These are questionnaires, interviews and document analyses.

3.5.1 Questionnaires

A questionnaire, according to Cohen, Manion and Morrison (2013), Creswell and Plano Clark (2011) and Curry Nembhard and Bradley (2009) is a way of eliciting the feelings, beliefs, experiences, perceptions and attitudes of individuals being studied. In the same vein, Kelley *et al.* (2003) and Silva (2008) describe it as being a concise set of questions to collect information that addresses the research problem. This study employed two different sets of questionnaires for pre-service teachers and one for the mentors. The first one was a group-administered standardised questionnaire that was distributed to the two separate groups from the two teachers' colleges prior to teaching practice. The purpose of this questionnaire was to collect information on pre-service teachers' beliefs, expectations and pre-conceptions about mathematics and mathematics teaching before field experiences. This way, the researcher would be able to establish the impact of these impressions and notions on the pre-service teachers' practices during teaching practice. The second set of questionnaires was also administered in the middle of teaching practice to gather information on the pre-service teachers' experiences during teaching practice. This enabled the researcher to compare pre-service teachers' conceptions before teaching practice with their actual experiences during teaching practice. The third questionnaire was meant for the mentors to gather information on their experiences with pre-service teachers on teaching practice. This could (i) enable the researcher to ascertain how pre-service teachers could be assisted socially, educationally and academically to be successful

during teaching practice, (ii) shed light on factors affecting pre-service teachers' performances during teaching practice and (iii) inform the researcher on how significant teaching practice is on pre-service teachers' journey to becoming qualified teachers.

Although questionnaires have the advantage that information can be gathered from a large group of participants at the same time (Cohen *et al.,* 2013), it is difficult to measure participants' feelings towards "learning to teach". Even in open-ended questions, responses could be quite limited because the information gathered is not rich, in-depth or detailed (Denzin & Lincoln, 2011). For example, in question 71 of questionnaire 2, most of the participants described the mentors' behaviour towards them as "lazy, rude or supportive." The extent to which these mentors portrayed such behaviour was not clarified. These responses also did not clarify pre-service teachers' feelings and attitudes towards teaching. In this regard, the questionnaires were then followed by different focus group interviews for pre-service teachers and for mentors to seek clarification on the preceding responses. For example, mentors' practices were clarified in detail during pre-service teachers' focus group interviews, questions 19 to 21, where pre-service teachers were asked to describe the mentoring practices experienced with regard to challenges faced, guidance received, how often they met with mentors and their relationship with their mentors, in each case giving examples of what happened.

3.5.1.1 Data collection procedures

Questionnaire 1

One hundred and twenty mathematics pre-service teachers in their first year (sixty from each college) answered questionnaires prior to their teaching practice. This was to determine their expectations about mathematics teaching, teaching practice, learners and their nature of knowledge on campus. This study employed group administered standardised questionnaires. Standardised questionnaires, according to Siniscalco and Auriat (2005), are the same for all participants and the way the responses are coded or recorded is the same. Group administered questionnaires are given to a group of participants assembled together under the control of one or more people (Huseyin, 2009). The researcher administered the questionnaires in person and all pre-service teachers in the sample answered the same questionnaire

in two separate groups, from the two teachers' colleges under the supervision of the researcher and their responses were also recorded in the same manner. The questionnaires were closely monitored so that the participants could not discuss the answers to ensure the validity of the results. This enabled the interpretation of results to be consistent and objective. However, Huseyin (2009) argues that this style of answering questionnaires creates the risk of the participants discussing ideas and copying each other. This may affect the reliability of the collected data. The researcher dealt with this weakness by being present during the time the questionnaires were being answered. Each group of participants answered the questionnaires at their respective colleges in the lecture rooms. Even though the groups were big, it only took them one hour to complete the questionnaire. This supports the view by Cohen *et al.* (2013) that questionnaires are economical in terms of time and money. Furthermore, the questions were easy to answer because the questionnaire was relatively short, clear and straightforward. Although Huseyin (2009) claims that the modification of questions can hardly be made on questionnaires, the instructions were clear and complete.

The questionnaire firstly required the participants' demographic data after which it was divided into several sections. Each section included questions that sought to answer the same research question. Some of the sections included expectations about teaching, beliefs about teaching, pre-service teachers' nature of mathematics knowledge on campus and knowledge of learners. The questionnaires had restricted and unrestricted questions. The restricted questions required short answers such as "agree" or "disagree", while the unrestricted (open-ended) questions called for free responses from the participants (Tuckman, 1999). However, Milne (1999) says that with questionnaires, it is difficult to assess beliefs and attitudes of people being studied. It is possible that participants can conceal their attitudes or feelings and embark on expressing opinions that they feel are acceptable to the researcher. For example, in question 10 of questionnaire 3 (for mentors), most mentors expressed their ability and desire to provide useful feedback and support to develop their mentees, which was diametrically opposite from what the mentees expressed about the mentors. However, the researcher attempted to counter this problem by clearly explaining to the participants before the exercise what the purpose of the research

was, how crucial it was to be honest when answering the questionnaire and what the collected information would be used for. In addition, it was difficult for some individuals to predict the future of what they have not experienced, hence compromising the validity and reliability of the data but the number of such participants was so insignificant that it could hardly affect the results.

Compared to other methods of collecting data, questionnaires are reliable in the sense that the participants remain anonymous and information from them is confidential (Cohen *et al.,* 2013). Based on this, participants did not write their names on the questionnaires. In order to decide on whom to follow-up with and link the information on questionnaire 1 to the follow-up questionnaire, the researcher used pseudonyms instead of actual names in order to hide the participants' identities.

Questionnaire 2

Before the second questionnaire was administered, the researcher obtained information from the respective colleges on the pre-service teachers' school placements. After obtaining permission from the respective schools, follow up questionnaires were administered to the same group of pre-service teachers who answered questionnaire 1, towards the middle of teaching practice, to provide answers on whether pre-service teachers' expectations matched their experiences during teaching practice. Two of the expected participants did not make it for teaching practice while thirteen did not answer the questionnaire because of various reasons. This time the pre-service teachers did not answer the questionnaires as a group because they were deployed to different schools in different areas. This resulted in the researcher facing challenges collecting questionnaires from the participants. Sometimes some pre-service teachers could not be found at their work places. Questionnaire 2 was a self-administered questionnaire that was given to the participants and then they were left alone to answer the questions at their work places. The researcher delivered the questionnaires in person and collected them a week later. In total, 87.5% (105 participants) answered and returned the questionnaires during teaching practice but some of them had blank or uncompleted spaces.

Similar to questionnaire 1, the questions in questionnaire 2 were divided according to the objectives of the research. It was longer than the preceding questionnaire and it took about one hour and fifteen minutes to complete. The questionnaire also included restricted and unrestricted questions.

Questionnaire 3

This questionnaire was administered to 50 school-based mentors after obtaining permission from the school heads. The questionnaire was relatively short. The purpose of this questionnaire was to determine mentors' views about pre-service teachers' strengths and weaknesses during teaching practice, the nature of mathematics knowledge they gained and the knowledge they acquired during teaching practice. Each mentor was given approximately 40 minutes to complete the questionnaire in his/her office. The researcher collected the questionnaires on the same day. It took the researcher approximately one week to distribute all the questionnaires to all the participants in the various schools. The researcher collected 84% (42/50) of the completed questionnaires that were distributed. The researcher administered the questionnaire in person and no risks were experienced from this participation. The structure of the questionnaire included mentoring practices, mentors' views on pre-service teachers with regard to the nature of knowledge and educational practices as well as mentors' relationship with mentees.

3.5.2 Interviews

An interview, according to Hancock (2002) and Guba and Lincoln (2005), is a face-to-face verbal communication used to obtain information about a topic from one or more people being studied. Ritchie and Lewis (2003) agree with this definition by defining it as a managed verbal exchange. Clough and Nutbrown (2007) explain that its effectiveness depends on the communication skills of the interviewer. Some of these skills include the ability to construct questions (Cohen *et al.,* 2007), good listening skills (Clough & Nutbrown, 2007) and establishing a good rapport with the participants. In the process of interviewing participants, Huseyin (2009) advises that interviewers should watch for certain characteristics that they portray which may affect the objectivity of the results. He claims that interviewers sometimes unintentionally give their own clues about the answer to a question or their

expectations of a participant. An Interviewer's responses during interviews, such as " good", "okay", "I agree" or "is that so?" may give clues to the participant about what the interviewer expects from him/her (Huseyin, 2009). The interviewer portrayed such behaviour in this study during the pilot study but revised her questioning techniques during the main study. In addition, asking leading questions can be a threat to the validity and reliability of data (Newton, 2010). In this study, this was countered by pre-testing the interview by conducting a pilot study. The researcher also used the skill and expertise that she accumulated through reading literature, advice from the supervisor and other professionals with such experience.

According to Hancock (2002), Huseyin (2009) and Merriam (2009), there are different types of interviews. Merriam (2009) distinguishes them according to the degree of structure, which is associated with the purpose of the study. Since this study aims to establish the contribution of teaching practice to teacher knowledge, college-based supervisors were approached individually to elicit information on teaching practice without the influence of others. Hence, semi-structured interviews were conducted with them. Focus group interviews with pre-service teachers and school-based mentors were also conducted in their respective groups in order to collect a wide range of ideas from them.

Individual semi-structured interviews

In the study, semi-structured interviews were incorporated because, according to Morse and Richards (2002), open-ended questions allow individuals the time and the scope to discuss their perceptions and knowledge. In addition, semi-structured interviews are a qualitative method of inquiry with a set of questions that are planned, which provides an interviewer with opportunities to explore a particular topic (Tuckman, 1999). Whilst questions can be asked in a systematic and consistent way, Tuckman (1999) states that, during an interview, the order of questions can be altered and sometimes the interviewer can forgo and digress from the questions in his/her effort to seek clarification. This means that the semi-structured interviews do not restrict participants to a set of predetermined answers. In this study, the order of questions remained the same but depending on the responses, the interviewer asked probing questions to seek clarification. For example, number 20 of the semi-structured questions sought to establish whether there were any formal requirements

(credentials) for mentor teachers during field placements of pre-service teachers. Most of the participants explained what was supposed to be done by the teachers' colleges and what attributes of mentors could be considered the best, instead of explaining what was happening on the ground. So, by asking further questions on how the college did the assessment, I established that the colleges rarely stipulated the kind of mentor they expected from the schools. According to Denzin and Lincoln (2011), words in the interview can sometimes be changed without changing the meaning of the question. This is because different individuals understand words differently, so there is need to clarify the questions to individuals by using the words that they understand.

The semi-structured individual interviews were preferred in this study for college-based educators because the interviewer's purpose was to use conversations, discussions and the questioning of college-based educators to provide an insight into the nature of mathematics knowledge that the pre-service teachers learn during their time in college. The interviews also provided insight into what pre-service teachers learn about mathematics teaching, their views about orientation before and during teaching practice and about their experiences during teaching practice.

Whilst semi-structured interviews provide valuable information about pre-service teachers' experiences and the use of pre-determined questions provide uniformity (Cohen *et al.,* 2013), the comparability of data loses weight because phrases may be different in each interview (Patton, 2002). However, the researcher's main concern was to check and probe where there were doubts. The fact that the interviewer maintained the meaning of the question, even if words were changed, promoted the validity of the data collected (Denzin & Lincoln, 2011).

Focus group interviews

In a focus group interview, participants are interviewed as a group. According to Vanderlinde and Braak (2010), focus group interviews are used to collect information about opinions and experiences of a group of people regarding a specific topic. Huseyin (2009) agrees with Vanderlinde and Braak (2010) and adds that participants in group interviews can discuss and develop a topic in such a way that the interviewer collects a wide range of ideas while at the same time attempting to

understand the different perspectives between the groups. This means that the interviewer relies on the discussions and interactions between interviewees in a group interview. Curry *et al.* (2009) advise that the number of participants for the group interviews must not be too large because not all participants will be able to be involved in the discussion, defeating the whole purpose. The study therefore intended to interview five groups of five people each. However, this did not go as planned because it was difficult to assemble the mentors or pre-service teachers from different schools together to form a group of five. The researcher therefore interviewed the mentors or pre-service teachers from the same school as a single group. As a result, some of the groups had more than five participants whilst some of them had as few as two people. In total, 22 out of the 25 expected pre-service teachers and 14 out of the 20 expected mentors were interviewed. It was difficult to get hold of some participants because it was in the middle of public examinations.

Curry *et al.* (2009) and Shoaf and Shoaf (2006) identify some characteristics of focus interviews. The interviewee is purposely chosen because s/he is known to have participated in certain situations. In addition, the researcher asks questions to a group of participants with the intention of reaching a provisional analysis. The interview guide is then produced based on the provisional analysis and the result of the focus group interview is determined by how the interviewee has defined the situation.

Based on this, the study interviews were conducted on pre-service teachers who had participated in the initial questionnaires. The intention of these interviews was to solicit data that established pre-service teachers' experiences during teaching practice and how these were related to their prior beliefs and expectations before teaching practice. The result helped the interviewer to establish how teaching practice could be refined so that its contribution to teacher knowledge is effective in teacher education. Hence, the outcome of the focus group interview partly determined the result of the study.

According to Chu (1993), a successful focus group interview should seek in-depth, self-reported experiences as well as the participants' feelings about those experiences. Hence, the study sought to elicit information on pre-service teachers'

experiences and their feelings about those experiences.

Curry *et al.* (2009) identify weaknesses of this type of interview. One of the weaknesses is that participants of the group may have their opinions influenced by other participants' comments during interaction. In this case, the interviewer, who was also the researcher, was present to control and guide the dialogue. Despite the influence of ideas, this type of interview provides new insights about pre-service teachers' perceptions and behaviours and it develops a deeper understanding of the subject being discussed (Chu, 1993).

3.5.2.1 Data collection procedures

Semi structured interviews

According to Tuckman (1999), prior to conducting an interview, the researcher needs to be clear about the people who are going to be interviewed, the information one wants to obtain and the manner in which to collect the data. Individualised semi-structured interviews with seven college-based teacher educators were therefore conducted to determine their views regarding the nature of mathematics knowledge that pre-service teachers learn during their time in college, what they learn about mathematics teaching, views about pre-service teachers' orientation before and during teaching practice and views about their experiences during teaching practice.

The semi-structured nature of the interview allowed for the probing of certain ideas thereby acquiring a deep understanding of the college-based teacher educators' thoughts and feelings as well as what they experienced during teaching practice (Cohen *et al.,* 2013). Hossain (2011) contends that qualitative research, in this case represented by semi-structured interviews, is emergent rather than tightly predicted. This means that even if a guide for questions was necessary, the researcher did not necessarily strictly adhere to these questions. Depending on the person being studied and the responses given, some of the questions were refined, replenished and reorganised. For example, question 15 of the interview reads; "In your view, is the current curriculum adequate to prepare pre-service teachers for teaching practice?" Most of the participants did not answer the question directly. The researcher suspected they did not quite understand what the question required and

this prompted the researcher to investigate the actual components in the curriculum and the manner in which each one of them helped the pre-service teachers on teaching practice.

The researcher ensured that the participants were informed of the day and time of participation so that they prepared, for example, excusing themselves from other commitments to avoid lesson disturbances and/or emotional distress. Some of the interviews were held in the interviewer's office, others in the participants' respective offices and one was held over the phone. The lecturer interviewed over the phone was not at college during the time of the interviews. The rest were interviewed face-to-face. The researcher explained to the respondents the reasons for conducting the interviews. The researcher audio recorded these interviews. Each interview lasted approximately one hour and each participant was interviewed once. Among the seven participants, two taught mathematics education and the rest were mathematics content lecturers.

Focus Group Interviews

Pre-service teachers: The first set of focus group interviews were conducted with 22 pre-service teachers (88%) on teaching practice, from 7 focus group interviews after completing the second set of questionnaires. The initial target was 25 (5 per group) pre-service teachers. The respondents were purposively chosen. One group was selected from those teaching in rural areas and six from different urban areas. An interview schedule was designed with key questions to be used as reference. During the interviews, reference was also made to the questionnaires completed before and during teaching practice. Questions were asked to determine pre-service teachers' views regarding their prior beliefs and expectations, experiences during teaching practice, that is, educational experiences and mentoring experiences. The pre-service teachers were asked how these experiences differed from their prior beliefs and expectations and the contributions and limitations of those experiences towards "learning to teach" mathematics. These were conducted as a follow-up to the questionnaires answered before and during teaching practice. Some of the issues, which were unclear on the questionnaires, were clarified during the interviews. For example, in question 41 of questionnaire 2, most participants agreed that the mentors gave them constructive support and feedback. This was exactly the

opposite of how they answered the same question during the interviews. It was therefore unclear whether (i) they understood the question in questionnaire 2 or (ii) if they thought about the question in relation to the theory taught in college, or (iii) if they just wanted to impress the interviewer. Their responses were then clarified during the interviews in question 19 of the focus group interviews (for pre-service teachers). For this particular question, pre-service teachers were asked to describe the mentoring practices that they received from their mentors. The way they were mentored during teaching practice became explicit when they were given the opportunity to express their views during interviews.

The interviews were conducted in the library at most of the schools where the students were teaching, after seeking permission from the respective heads of the schools and college principals. A few were held in the staffrooms. The researcher had to liaise with the participating colleges first so that the interviews would not clash with the college staff's field visits to participants.

The interview schedule was divided into four sections namely, name and background of participant, experience during teaching practice, mentoring practices and educational experiences. Each section intended to address certain objectives of the study.

The researcher audio recorded the discussions. In addition, she used field notes to record the dialogues. However, this method of data recording (field notes) disrupted the communication between the researcher and the participants, as confirmed by Brenner (2006), who advises that the interviewer should delay note taking until the participant has finished explaining the point. Sensing that there was the probability of forgetting some facts during conversation, the researcher used an audio recorder to record the conversations. This is in line with the proposal by Merriam (2009) that quotes should be taken verbatim when collecting qualitative data. Brenner (2006), however, asserts that participants may be reluctant to express their feelings if they realise the information is being recorded. One group of pre-service teachers (focus group interview 4) denied permission to be audio taped, indicating that they were not comfortable with the recording. The interviewer consented to their request and had to write down notes from the discussions. The interviewer, however, explained to the

participants how confidential this information was and as a result, the conversations created a sense of shared interest, which resulted in deeper discussions of the topics concerned.

According to Gomm (2004), empathetic relationships between the researcher and the participants might enable the participants to disclose the truth to the researcher. This implies that there should be a mutual warm relationship between the researcher and the participants so that they will feel protected when they disclose information to the researcher. According to Chu (1993), the interviewer therefore needs to promote cooperation with the participants to elicit reliable answers from them during interviews. The researcher thus relinquished control of the interview and encouraged them to participate freely whilst supervising the discussions so that they did not digress but remained on track. Each interview lasted about fifty minutes and each group was interviewed once.

At the end of each question, the interviewer summarised the points that the participants provided and allowed them to comment in order to ensure that they were not misunderstood, hence, enhancing reliability.

Mentors: Focus group interviews with 5 groups of school-based mentors were conducted to determine mentors' views about pre-service teachers' strengths and weaknesses during teaching practice, the nature of mathematics knowledge possessed and how they learnt about mathematics teaching during field experiences. These were conducted as a follow-up to the preceding questionnaire. Four groups were selected from different urban schools whilst one came from rural schools. The participants were informed of the interviews beforehand so that they could prepare for the interviews. Although some participants could be reluctant to express their feelings if they are being recorded (Brenner, 2006), all the participants of this interview agreed to audio recording. Each set of interviews took at most 40 minutes. The interviews were held in different places for each group. Some were held in the staffroom, some in the offices and one in the classroom.

3.5.3 Document analysis

According to Bowen (2009), document analysis is a qualitative research

methodology in which documents relating to the topic under investigation are interpreted and analysed by the researcher. Three types of documents are (i) public records, (ii) personal documents and (iii) physical evidence (artefacts). An analysis of pre-service teachers' study materials (textbooks), colleges and school syllabi and college timetables and schemes of work was done to provide additional data on what pre-service teachers learn as part of the programme.

In this study, I focused on the pre-service teachers' syllabus at college level, which is an example of public records. Since it is possible that work reflected in the syllabus can be different from what is taught in the classroom, the researcher found it necessary to check the schemes of work reflecting the topics taught to pre-service teachers during their time on college campus. This was only used as a follow-up to pre-service teachers' questionnaires, interviews and college-based teacher educators' individualised interviews. The only purpose of document analysis in this study was to confirm the mathematics content knowledge, subject pedagogical content knowledge and curriculum knowledge (teacher knowledge) that pre-service teachers were taught in relation to their responses in the interviews. What they learnt in college (as reflected by the syllabus and schemes of work) was compared to what they taught in schools to find out if there was any link (relevance). Hence, textual data from the textbooks they used to teach and school syllabi were also examined. For example, questions 40 and 41 of questionnaire 1 (for pre-service teachers before TP) and questions 57 and 62 of questionnaire 2 (for pre-service teachers during TP) were asked to pre-service teachers to indicate whether the nature of knowledge covered in college was necessary or relevant for mathematics teaching in high school. Their responses could reliably be confirmed by observing the actual content covered in the syllabi and an analysis of how this textual data could be linked to their profession. In addition, participants may have wanted to impress the researcher during interviews and questionnaires by giving answers that are socially acceptable to the researcher (Crabtree & Cohen, 2008) but may have been diametrically opposite to what is happening in the classroom. Kawulich (2005) contends that knowledge is generated through observation. This, therefore meant that the researcher was required to observe and analyse the pre-service teachers' syllabi so that she would not only depend on what pre-service teachers and supervisors said

about the content taught but also on what she saw in the public documents.

College syllabi from the two teachers' colleges were collected, interpreted and analysed during teaching practice after the questionnaires and interviews. In addition, school syllabi and textbooks (New General Mathematics books 1 to 4) were also collected and analysed during school visits to examine whether they matched the content taught at college. This enabled the researcher to establish whether the content taught on college campus has any effect on the performance of pre-service teachers during teaching practice. The observation, interpretation and analysis of documents were recorded in the form of written notes.

3.6 Data analysis procedures

3.6.1 Quantitative data: Questionnaires

Quantitative data analysis is defined by Bryman (2006) as a systematic approach to investigations where numerical data is either collected or that the researcher transforms collected data into numerical data. According to Bryman (2006), it describes an event, which answers the questions "what?" or "how many?" This implies that it involves measuring quantities. In this study, quantitative data was gathered through questionnaires. The research questions in this study sought to find out what and how pre-service teachers reportedly learn mathematics and mathematics teaching during teaching practice.

Quantitative analysis, according to O'Neil (2006), enables the researcher to communicate the meaning of collected data by organising and summarising it. Hence, before the analysis of data, the researcher ensured that the data was organised in a logical manner that facilitated analysis. The data was then entered on a distribution table to show the number of participants and scores located in each category. This assisted the researcher to establish the number of participants in each category, the spread of the scores and those that were entered correctly or incorrectly. For each questionnaire, the questions were grouped according to the research questions being addressed so that the summarised score on a Likert scale could reliably measure a particular behaviour (Vanek, 2012).

3.6.1.1 Descriptive analysis

The responses to the questionnaires were presented and analysed on a 5-point Likert scale of strongly disagree (SD), disagree (D), neutral (N), agree (A) and strongly agree (SA). Each response (SD, D, N, A, SA) was given a weighting ranging from 1 to 5 respectively to allow the calculation of means and standard deviations. This meant that the mean of 1 would stand for SD whilst a mean of 5 or close to 5 would mean SA. However, for the purpose of analysis, the Likert scale was then collapsed from five choices to three, that is, "disagree", "neutral" or "agree".

The disagreement of a concept was considered to be among the category of averages (1–2.9 or below 3), 3 stood for moderate (neutral) or the decision point. Within the range $3 < x \leq 5$ was a strong agreement. In some cases, percentages for different responses were calculated and analysed. Standard deviations were calculated to find out how wide the variation was of any set of cases or the range in which most cases fell (Stenner, Rock & Donald 2005). Bar graphs were also constructed in order to provide an illustration of the distribution of data being analysed. Table 3.2 below is an example of how data was analysed using descriptive statistics explained above, using the data collected from the pilot study.

For example:

Research question 1

What are the expectations of "learning to teach" by pre-service teachers at two Zimbabwean colleges of education prior to their teaching practice?

To answer this question, the researcher used data from questionnaire 1. The following items were extracted from the questionnaire and the averages and standard deviations were calculated using the SPSS program as follows:

Table 3.2: Extract of responses from questionnaire 1 analysed

ITEM N0.		RESPONSES & FREQUENCIES					AVERAGE	Std. Dev.
		SD	D	N	A	SA		
	SCORE	**1**	**2**	**3**	**4**	**5**		
7	I can organise a lesson to boost student learning	0	0	2	10	8	4.28	0.665
8	I know how to manage my classroom	0	1	5	10	4	3.91	0.773
9	I can vary my teaching approaches	0	1	1	8	10	4.37	0.750
10	A variety of approaches to teach a concept confuses students	4	7	3	4	2	2.66	1.297
20	I can assess students' learning in various ways	0	1	4	11	4	4.15	2.79
30	Mathematics is more effective if the teacher has more content	6	8	3	2	1	2.33	1.198
27	Mathematics needs a smart teacher for students to pass	2	2	3	8	5	4.01	3.887

In this case, the results show that the pre-service teachers had high expectations of doing well in the classroom management (4.1), lesson organisation (4.28), and ability

to use various teaching and assessment approaches, which are also in the range of four. However, the table shows that pre-service teachers believed that teaching mathematics was independent of the amount of content the teacher has (2.33), although the teacher required a certain standard of knowledge (item 27) for students to pass (4.01). Even though most participants were boasting about the ability to use various approaches in the classroom, they were not sure (2.66, item 10) whether the use of various approaches to teach a concept would confuse the learners. On average, the results show that pre-service teachers had more positive expectations about teaching than negatives before they went on teaching practice.

The use of standard deviations was fundamental to this study. A high standard deviation means the responses vary greatly from the mean. A low standard deviation indicates that the responses are close or similar to the mean. From the above example, at first glance, it seems the ability to organise a lesson (item 7) and the ability to assess students' learning in various ways (item 20) are equally rated and participants' expectations were positive in these areas because the means are almost the same. However, the standard deviation for "the ability to assess" shows that the responses were polarised. In this case, the responses were extremely different, which means that, some participants were confident that they would be able to assess the learners in various ways (SA = 5), whilst some were in total darkness as to how they would assess the learners (SD = 1). The mean alone does not inform the full story of participants' responses, which makes the distribution (standard deviation) crucial in the study.

3.6.1.2 Cross tabulation (the chi-square test)

The chi-square test was conducted to show the association that existed between pre-service teachers' demographic data and some of their responses in the questionnaires. The null hypothesis was that "there is no association between the two components". The alternative hypothesis was "there is an association between the two components". To avoid concluding that the association exists when it does not, the criterion (p) had to be a probability of less than 0.05, implying that the null hypothesis is rejected if $p < 0.05$, in favour of the alternative hypothesis. This would then indicate that there is at least 95% confidence that any association was not due to chance, meaning that the relationship is actually there.

3.6.1.3 Inferential statistics

(a) Paired samples t-test

The paired samples test was conducted to establish the significance of the differences between the means of "expectations of learning to teach" before TP and "teaching experiences" during TP, at 95% level of significance. The test was performed using the SPSS program.

(b) Paired samples correlation

The use of the paired samples correlation was also necessary to study and determine the degree of association between expectations of learning to teach and classroom experiences. The value of gamma calculated ranges from -1 to 1 and the closer gamma is to 1 or -1, the stronger the association (DeVault, 2015). If the value of gamma is zero or close to zero, it indicates the absence of association.

(c) Factor analysis

A factor analysis was also conducted as a data reduction tool. The purpose was to remove duplication from a set of correlated variables under various themes (Yong & Pearce, 2013). Each factor (F_i) was a linear combination of the variables (questions) under a given theme. The general formula for each factor (F_i) is given by $F_i =$ $\sum_{j=1}^{n} b_{ij}\, x_j + e_i$ where

$b_{ij} =$ the coefficient or factor loading of the variables (questions) in the ith row and j^{th} column.

$x_i =$ the variables under a given theme

$e_i =$ error term

For example: Factor 1 ($F1$) = $b_{11}\, x_1 + b_{12}\, x_2 + b_{13}\, x_3 + \ldots\ldots + b_{1n}\, x_n + e_1$

$$F2 = b_{21}\, x_1 + b_{22}\, x_2 + b_{23}\, x_3 + \ldots\ldots + b_{2n}\, x_n + e_2$$

$$Fm = b_{m1}\, x_1 + b_{m2}\, x_2 + b_{m3}\, x_3 + \ldots\ldots + b_{mn}\, x_n + e_m$$

For each factor, if the factor loading (b_{ij}) of the latent variable was at least 0.5 then it meant that the respective latent variable had a major impact on the theme. In this study, the factor analysis was used on themes with more than 10 items so that the reduction concept could be realised.

An index (I_n) showing participants' satisfaction about teaching practice under different themes was also calculated using the "averages" of the latent coefficients. The formula below was used to calculate the satisfaction index (I_n).

$$I_n = \frac{A_v - |a|}{|A| - |a|} \quad \text{where}$$

A_v = Grand average (average of the averages of the latent coefficients for each factor).

$|a|$ = The modulus of the smallest average of the latent coefficients in each column.

$|A|$ = The modulus of the largest average of the latent coefficients in each column.

3.6.2 Qualitative data

A table was designed to summarise the themes, sub-themes and categories that emerged from the data collected in relation to the research questions of the study. The data was then presented and analysed as described below.

3.6.2.1 Focus group interviews

Most of the focus group interview data was in audio (verbal) form, which was transcribed into textual data. Some non-verbal responses were recorded using field notes. The researcher then systematically presented, interpreted and explained the qualitative data. Qualitative methods were used to analyse and examine the way pre-service teachers conceptualised the teaching of mathematics for understanding during teaching practice. In this way, I was guided to characterise what pre-service teachers paid attention to during teaching and had evidence of what pre-service teachers claimed in the questionnaires about their instructional practices in relation to their experiences. Hence, focus group interviews for pre-service teachers sought

to find out information regarding pre-service teachers' experiences and their feelings about those experiences. The researcher thus focused on describing the nature of the mathematical tasks that pre-service teachers gave to the learners and the approaches used to create representations of the mathematics taught in the classroom in order to communicate knowledge to the students. The researcher also sought to discover what learning tools/resources and classroom management the pre-service teachers used and the manner in which these affected their performances during teaching practice. In addition, the challenges, weaknesses and strengths that the pre-service teachers experienced during teaching practice were also examined and analysed to find out how these had prepared them for teaching. Hence, the questions in the focus group interviews were grouped into related components and pre-service teachers' responses were interpreted and explained to establish their analysis about teaching.

An explanation and analysis of how pre-service teachers' beliefs and expectations matched their experiences during teaching practice was also conducted to establish how best pre-service teachers could be prepared in college for teaching practice. The significance of teaching practice was established by probing their perspectives on how they viewed teaching practice as part of "learning to teach". This gave the researcher an idea of the importance and contribution of teaching practice to teacher performance.

The interpretive approach was used to analyse school-based educators' (mentors) perceptions of mentoring practices and their views about pre-service teachers' performance during teaching practice. This was an attempt to investigate how mentors valued the exercise of mentoring and acquire suggestions on how strengths and weakness could be complemented or improved to produce better quality teachers. The audio tapes were played several times and transcribed to find out how the mentor responses attempted to address the research questions of the study.

3.6.2.2 Semi-structured interviews

Individualised semi-structured interviews were conducted with teacher educators to determine their views on how they prepare pre-service teachers for teaching practice. Interviews focused on the nature of the mathematics content pre-service

teachers learn in college, what they learn about mathematics teaching and their views about pre-service teachers' orientation on teaching practice and their experiences.

The qualitative nature of the data collected through semi-structured interviews required an interpretive analysis. Audio recordings of the interviews were also replayed several times to assist with the analysis process. Categories that addressed the same research questions were extracted for further analysis. Each category of responses was interpreted and transcribed to determine the lecturers' views concerning the mathematics and mathematics teaching that pre-service teachers are taught in preparation for teaching practice. Field notes and audio recordings made during the interviews were analysed in conjunction with the pre-service teachers' responses during focus group interviews. Analysis also involved reading field notes several times in order to identify the extent to which participants were involved in pre-service teachers' teaching practice preparation and lecturers' views about pre-service teachers' nature of knowledge and how this assisted the pre-service teachers during teaching practice.

Semi-structured interviews informed the researcher on how pre-service teachers are prepared before teaching practice and whether challenges faced by pre-service teachers on teaching practice can be attributed to college preparations or field experiences. This knowledge enabled the researcher to establish the specific areas during "learning to teach" which need attention to improve pre-service teachers' performance (the quality of teachers under training).

3.6.2.3 Document analysis

After assessing the mathematics content and the mathematics education covered by pre-service teachers in the college syllabi and the schemes of work reflecting the topics taught, the information was compared with the responses of the pre-service teachers and their educators in the questionnaires and interviews. The researcher believed this would improve the validity of the findings of the study. The contents of the college syllabi were also analysed to investigate their link with the mathematics content taught in high schools. Below is a summary of the research processes trailed by the researcher during the study.

3.6.3 Summary of the research processes in form of a table

Table 3.3: Research process in this study

PURPOSE/RESEARCH QUESTION	DATA COLLECTION STRATEGIES	DATA SOURCE	ANALYSIS PROCEDURE
What are the expectations of "learning to teach" by pre-service teachers at two Zimbabwean Colleges of Education prior their teaching practice?	Questionnaires, focus group interviews	Pre-service teachers	Descriptive statistics, factor analysis, chi-square test
What do the pre-service teachers reportedly learn about mathematics during teaching practice?	Questionnaires, Focus group interviews, semi-structured interviews and document analysis	Pre-service teachers, college lecturers, text books and syllabi	Descriptive statistics, interpretive analysis
What do the pre-service teachers reportedly learn about mathematics teaching during teaching practice?	Focus group interviews, questionnaires, semi-structured interviews	Pre-service teachers, mentors, college lecturers	Descriptive statistics, factor analysis, chi-square test, interpretive analysis
How do the pre-service teachers reportedly learn about mathematics and mathematics teaching during teaching practice, that is, what structures, resources and tools are employed during the "learning to teach" process?	Focus group interviews, audio recordings	Pre-service teachers, audio clips of interviews, mentors and college	Interpretive analysis descriptive statistics

PURPOSE/RESEARCH QUESTION	DATA COLLECTION STRATEGIES	DATA SOURCE	ANALYSIS PROCEDURE
		lecturers	
What are the differences between the pre-service teachers' expectations and what they reportedly learn during teaching practice?	Questionnaires, focus group interviews	Pre-service teachers	Descriptive statistics interpretive analysis
How can the pre-service teachers' experiences of "learning to teach" from teaching practice and their expectations be explained?	Questionnaires, focus group interviews	Pre-service teachers, presented data from questionnaires and interviews	Paired samples correlations, interpretive analysis, paired samples test
What suggestions and recommendations can be made to improve the experiences of "learning to teach" for the mathematics pre-service teachers?	Group interviews, audio recordings	Pre-service teachers, mentors, college lecturers, literature review.	Interpretive analysis

3.7   Validity and reliability

The meanings of validity and reliability differ in quantitative and qualitative research (Cohen *et al.,* 2013). Golafshani (2003) posits that reliability in quantitative research means the same as consistency over time with a group of participants and that it is concerned with precision and accuracy. He further defines it as the extent to which results of a study are repeatable. To test the repeatable nature of the questionnaire, the questionnaire was pre-administered separately to two groups (not in the study sample) at the two teachers' colleges in a pilot study to establish whether the responses were similar. The two colleges have the same catchment area of pre-

service teachers who have the same qualifications and thus it is justifiable to assume that the two groups were similar. Furthermore, to ensure that the results of the study were dependable (to test validity) I made a point of ensuring that the participants were not sharing information during the completion of the questionnaires. Moreover, the participants were not allowed to write their names on the questionnaires so that they did not feel that they were being interrogated. Open-ended questions on the instrument were minimal in order to make the questionnaire easy and interesting to answer.

The researcher used the SPSS version 23.0 to analyse the quantitative data. The three questionnaires were tested for reliability using Cronbach's alpha coefficient. Cronbach's alpha coefficient, according to Tavakol and Dennik (2011), is a measure of the consistency of items in a questionnaire to establish how closely related they are as a group. According to Yong, Hua and Feng-Mei (2007), although it is recommended that the instrument should record the reliability coefficient of at least 0.7 for a strong estimation of reliability, the coefficient of $0.6 \leq \alpha \leq 0.7$ is still considered "acceptable" for the content of an instrument. The three questionnaires were further divided into different themes to answer the research questions of the study. Cronbach's alpha for the items in each one of the themes was also calculated.

In qualitative data, repeatability of results does not suffice (Hancock, 2002). Reliability in qualitative research, according to Guba and Lincoln (2005), is synonymous with credibility, trustworthiness or applicability. This refers to the degree to which the reader is convinced that the results of the study occurred as the researcher says they did (Guba & Lincoln, 2005). To meet the criteria of trustworthiness and credibility, the researcher used audio recordings and prolonged engagement with the participants. This supports the idea by Lincoln and Guba (1985) that the researcher needs to be in a close relationship with the environment to ensure credibility of data, which I believe is brought about by engaging the participants for a lengthy period. This was not a drawback to the study because the researcher was dealing with most of the participants since the beginning of the study.

According to Cohen *et al.* (2007), the validity of an interview may be compromised by

the interviewer's attitude, opinion and expectations towards the participants. This means that the interviewer may have the tendency to view respondents in her own image. This may result in the interviewer recording what she wants to hear instead of what has been said, hence causing bias on the collected data. On the other hand, the interviewer may fail to understand what the participant is saying. To ensure that this is minimised, member checks were used. The researcher checked with the participants if they agreed with the transcription of the collected data from them so that they were not misrepresented (Koelsch, 2013). At the end of each question in the interviews, the interviewer established transparency by summarising the points that the participants had provided and allowed them to comment in order to ensure that the information was correct and that they were not misquoted thereby enhancing the validity of data collected. For example, on item 13 of the transcribed data (focus group interview 3 for pre-service teachers), the researcher summarised the points that had been described by the pre-service teachers on what they expected prior to TP, to confirm the authenticity of what she was recording. In addition, the interviewer, by taking control of the entire process, tried to prevent the discussions from digressing, thereby creating bias on the subject under review. Multiple sources of data were also used to ensure the reliability and validity of data collected. Hence, focus group interviews were conducted to clarify some of the issues raised during the questionnaires. For example, question 75 from questionnaire 2 asked pre-service teachers to write down their limitations in teaching. Most of them attributed their limitations to time management. The same question was asked in a different form during the focus group interviews for pre-service teachers (questions 7 and 8) but this time they were asked to explain challenges in their teaching. Through probing, they were able to clarify their challenges and limitations emanating from interactions with mentors, supervisors and sometimes the learners. After data collection, data from the questionnaires for pre-service teachers and mentors were also compared with data from the interviews to check for consistency in the participants' responses in order to improve the reliability of the study.

3.8   Pilot study

A pilot study, according to Arain *et al.* (2010), is a small study that substantiates the major study. It may also be called a feasibility small-scale study conducted in

preparation for the main study to ensure that ideas and concepts behind the research are workable (Creswell, 2014).

Hassan, Schattner and Mazza (2006) posit that a pilot study serves the purpose of testing research protocols and data collection instruments, among others. Furthermore, Simon (2011) agrees that pilot studies are meant to check that the questions in the instruments are understandable and that the items produce the required information that addresses the research sub-questions in the study. The pilot study was designed to pre-test the research tools. The instruments were administered to first year pre-service teachers who were not part of the study sample. This was compatible with what Hassan *et al.* (2006) and Spratt, Walker and Robinson (2004) suggest that a pilot study should be conducted with participants who are not from the population to be studied but are as similar as possible to the target population. The first questionnaire (before TP) was tested on twenty first year students and the second one (during TP) was administered to twenty third year students who had just come from teaching practice. Three first year students, one college lecturer and two mentors were interviewed. After administering the instruments, participants were given an opportunity to comment and ask questions to ensure that the ideas in the instruments were clear and straightforward.

One of the advantages of a pilot study, according to Hassan *et al.* (2006) and Simon (2011) is that it detects any weaknesses in the main study. From the pilot study, some open-ended questions in questionnaire 1 were found to be difficult and ambiguous for the participants and were therefore rephrased and reorganised. For example, the first questionnaire that was administered to twenty first year student teachers was quite comprehensible. However, question 51, which read "What needs and/or expectations do you have of the school administration (The head, D/head, and HOD)?" received a variety of responses with some not even applicable to the demands of the question. Whilst some pre-service teachers expected to get enough resources for teaching from the administration, some expected the administration to give them financial support, some expected the administration to understand them, to be considerate during the time of problems (problems not specified) or to feel sorry for them while some expected the administration to guide and support them. Some expected to have a good administration team. Some of the responses clarified

to the researcher that the participants did not quite understand the question. The question was therefore rephrased to "How do you expect the administration (head, D/head and HOD) to assist you to succeed in your teaching practice?" The question attempted to capture pre-service teachers' expectations on the administration in relation to teaching practice improvement and not anything else outside of this.

The issue of confidentiality was being violated in the first questionnaire when participants were asked to write down their email addresses. When this issue was raised during the pilot study, the email address was replaced by a pseudonym. Where the email address remained on the questionnaire, the participants were asked to leave it blank. However, some participants wrote their email addresses and some even wrote their names. These questionnaires were collected for analysis as they were. This resonates with what Chikutuma (2014) suggests, that after discovering unanticipated problems in a pilot study, the researcher has an opportunity to redesign the research tools to overcome problems that the pilot study revealed.

The second questionnaire was administered to another group of pre-service teachers who had just finished their teaching practice. This was a straightforward instrument as indicated by participants not asking further questions. Nothing was altered on this questionnaire. The interviews were conducted with three pre-service teachers who had previously answered the second questionnaire. Participants were allowed to ask questions at the end of the exercise. The questions were clear; however, the researcher did explain some of them during the discussions. The focus group interview schedule therefore, remained as it was without any changes.

Questionnaires and focus group interviews for mentors and semi-structured interviews for college-based educators were not modified. The data collected during the pilot study was not analysed together with the data from the main study because the data was collected on a trial and error basis. However, the researcher realised that it was necessary to add another instrument of document analysis in addition to the former instruments, in order to confirm the nature of knowledge pre-service teachers learn on campus. Textbooks used in schools and school syllabi were therefore assessed, interpreted and analysed to ascertain if there was any link

between what is taught in college and what pre-service teachers teach in schools during teaching practice.

3.9   Ethical considerations

Most researchers cite the need to promote public trust by adhering to ethical standards during research (Resnick, 2010). Trust in research promotes cooperative relationships between researchers and participants, hence participants are in a position to confide in the researcher and this may breed valid and trustworthy data (Resnik, 2010). Therefore, the research has been conducted with ethical approval from the University of the Free State. The university clearance was obtained after submitting a research proposal which outlined the purpose of the research, the research design, participants involved, how they were recruited, what they did, ethical considerations, risk mitigations as well as the data collection and analysis procedures. It was submitted at the end of May 2015 to the ethics committee. Approval was granted on 30 June 2015 with the ethical clearance number **UFS-HSD2015/0273** (refer to appendix 1).

The researcher also applied for permission to conduct the research to relevant authorities in Zimbabwe. In teachers' colleges, the study was granted permission by the Ministry of Higher and Tertiary Education, Science and Technology development and in high schools by the Ministry of Primary and Secondary Education and other relevant departments. This enabled the respective divisions to examine the research activities for ethical soundness, with consideration of issues of confidentiality, risk management, informed consent and others, prior to the collection of data from participants (Resnik, 2010).

(i)   Informed consent

Subsequent to the researcher receiving permission from the above authorities, participants were contacted and given enough information so that they could decide whether to participate (Webster, Lewis & Brown, 2014). Participants were briefed about the research and consent from college principals and school heads in Zimbabwe was obtained prior to contacting their teachers and student teachers in relation to the research. Participation in the research was voluntary and any

participant was free to withdraw at any time, with or without a reason (British Educational Research Association [BERA], 2011). The researcher also liaised with the participating colleges first, before commencing with field research so that the interviews and questionnaires would not clash with the college staff's field visits to participants. Permission from schools and colleges to conduct the research was granted in July 2015.

(ii) Confidentiality

Participants were also entitled to privacy (BERA, 2011; Girvan & Savage, 2012). Participants therefore remained anonymous and responses were kept confidential in order to protect their identities. No names appeared on the questionnaires. Only pseudonyms were used to facilitate the follow-ups.

(iii) Risk management

In order to release themselves from other commitments, be they personal or otherwise, the researcher ensured that the participants were informed of the day and time of participation so that they could prepare for it. This measure was done to avoid lesson disturbances and/or emotional distress. All participants involved were over the age of 18 and were only included in the study after completing the consent forms.

(iv) Integrity

The researcher needed to maintain research integrity by avoiding research misconduct (BERA, 2011; Regan, Baldwin & Peters, 2014) by preventing plagiarism, fabrication and the falsification of information, which could subvert her reputation, authority and trustworthiness as a researcher.

3.10 Summary of the chapter

The research was conducted in Zimbabwe, with special attention to first year mathematics pre-service teachers at two secondary teachers' colleges. By conducting a study on "learning to teach", through practice with pre-service teachers, mentors and teacher educators (college-based) as participants, it was anticipated

that the "the significance and contribution of teaching practice to teacher knowledge" would be investigated.

The first part of the chapter introduces the paradigm that underpins the study. This study is anchored on pragmatism, which is a belief that reality is realised through experience and observation (Terrell, 2012). In this chapter, I also described the research approach of the study, which involved the methods of data collection. The mixed methods approach was found suitable for this study because it is a method that requires dialogue with the participants as sources of information (Guba & Lincoln, 2005). The researcher focused on this method to realise the nature and impact of teaching practice on teacher knowledge through conversing with the pre-service teachers, mentors and college-based teacher educators.

Data was collected through questionnaires, focus group interviews, semi-structured interviews and the observation and analysis of documents. The explanatory sequential design was preferred during data collection. This is when data was collected by quantitative means, followed by qualitative means. This implied that quantitative results could be reorganised or replenished through qualitative means to ensure reliability (Terrell, 2012).

The other part of the chapter describes the sample and sampling procedures. The purposive sampling was suitable for this study design because it provided the desired information on the contribution of teaching practice to teacher knowledge during the process of "learning to teach". Different data collection instruments were used to collect data from different sources and various analytical tools were used to analyse different sets of data. Finally, I described the measures of ensuring validity and reliability of the findings, highlighted the use of the pilot study and underlined ethical considerations observed in this research. Next, is chapter 4, which deals with the presentation and analysis of the collected data.

CHAPTER 4

DATA PRESENTATION, FINDINGS AND ANALYSIS

4.0   Introduction

The purpose of the study was to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach" for secondary school mathematics in Zimbabwe. The study uses the mixed methods evaluation to analyse the link between the nature of pre-service teachers' prior experiences, expectations and beliefs against their practical experiences in the teaching field and beliefs during teaching practice. This chapter presents, interprets and analyses data from the field. The data was processed in response to the research questions posed in section 1.3 of this thesis.

Two quantitative questionnaires were administered to pre-service teachers, one before teaching practice (questionnaire 1) and another one during teaching practice (questionnaire 2). A third questionnaire was administered to teacher mentors in the schools (questionnaire 3).

The questionnaires were followed by focus group interviews (FGI) with the pre-service teachers and mentors. Semi-structured interviews (SSI) were also conducted with lecturers to determine their understanding of the pre-service teachers' experiences during teaching practice. Participants were identified by codes to ensure confidentiality, for example, "(FGI 2, A3)", means the quote is from focus group interview 2, participant A3. The interviews were conducted to illuminate the issues raised in the quantitative responses. The responses to pre-service teachers' questionnaires were juxtaposed against their FGI. The same was done for teacher mentors. College lecturers' SSI were analysed separately to confirm or refute the PST and mentors' views. This was done to answer the research questions of the thesis.

4.1   Description of the study sample

The sample of the study participants is presented in table 4.1

Table 4.1: Study sample

INSTRUMENT	PARTICIPANTS	PARTICIPATION COUNT	EXPECTED SAMPLE SIZE	PARTICIPATION PERCENTAGE (%)
Questionnaire 1	Pre-service teachers before TP	120	120	100%
Questionnaire 2	Pre-service teachers during TP	105	120	87.5%
Questionnaire 3	Mentor teachers	42	50	84%
7 Focus group interviews	Pre-service teachers	22	25	88%
5 Focus group interviews	Mentor teachers	14	20	70%
Semi-structured interviews	College lecturers	7	7	100%

Although the expected sample size of participants was not met in some cases, the percentages were acceptable (Sivo *et al.,* 2006). According to Sivo *et al.* (2006), although the response rate of 100% should be pursued, 70% to 80% is still acceptable.

4.2 Reliability and validity of the study

The questionnaires were tested for reliability using Cronbach's alpha coefficient. Cronbach's alpha coefficient was found to be 0.614 for the first questionnaire, 0.850 for the second questionnaire and 0.758 for the third questionnaire. According to Yong *et al.* (2007), although it is recommended that the instrument should record the reliability coefficient of at least 0.7 for a strong estimation of reliability, a coefficient of $0.6 \leq \alpha \leq 0.7$ is still considered "acceptable" for the content of an instrument. This suggests that the three instruments had a relatively high internal consistency. The three questionnaires were further divided into different themes to answer the research questions of the study. Cronbach's alpha for the items in each one of the themes was also calculated to give the following result as described in table 4.2.

Table 4.2: Reliability test for themes emerging from the study

Theme	Cronbach's alpha	Number of Items
Expectations of teaching before TP (table 4.6)	0.721	19
PST's mathematic content knowledge during TP (table 4.9)	0.482	8
Classroom experiences during TP. (table 4.10)	0.780	24
Knowledge about mathematics teaching (PST's views) – table 4.12	0.512	4
PST practicum experiences with learners (table 4.13)	0.785	4
Mentors' views about PST's classroom performance (table 4.14)	0.788	16
Experiences with mentors (table 4.16)	0.893	12

Even though Field (2005) asserts that a Cronbanch alpha below 0.7 indicates an unreliable scale, Kline (1999) notes that values below 0.7 can realistically be accepted when one is dealing with psychological constructs (abilities, attitudes, personal traits, etc.) because of the diversity of the constructs being measured. This justifies the relatively low scales (0.482 and 0.512) in table 4.2 since the respective themes measure such constructs.

4.3 Demographic data

4.3.1 Questionnaire 1

Table 4.3: Pre-service teachers' responses before TP

ITEMS	n =	DESCRIPTION	FREQUENCY	PERCENTAGE
Gender		Male	67	55.8%
	120	Female	53	44.2%
Age		18-20 years	13	10.8%
		21-25 years	55	45.8%
	119	26-30 years	24	20%
		31+ years	27	22.5%
High school attended		Rural day school	31	25.8%
		Urban government	53	44.2%
	120	Urban private	11	9.2%
		Mission school	25	20.8%
Institution		BTTC (a)	60	50%

ITEMS	n =	DESCRIPTION	FREQUENCY	PERCENTAGE
	120	HTC (b)	60	50%
Teaching experience before college	120	None	73	60.8%
		1 to 3 years	43	35.8%
		Over 3 years	4	3.3%

Table 4.3 suggests that in terms of age, there were very few pre-service teachers in the 18 to 20-year range. Most of the students in Zimbabwe, in this age range are likely to be still in school or have just left high school, which explains why the frequency is low in this category. The majority are in the 21 to 30-year range (79%). This can be associated with an active age group trying to fit into the world of employment. The 31+ range is relatively low, in part because it represents many of the people who would have pursued other careers but later on returned to study teaching. The table also shows that a large number of the pre-service teachers did not have prior teaching experience before they joined teachers' training colleges (60.8%). It also shows that 70% (44.2% + 25.8%) of the pre-service teachers attended high school in government schools and the least (9.2%) were from private schools. Male and female pre-service teachers were almost equally represented in the study.

4.3.2 Questionnaire 2

Table 4.4: Pre-service teachers' responses during TP

ITEMS	n =	DESCRIPTION	REQUENCY	PERCENTAGE
City		Harare	64	61%
	105	Bulawayo	41	39%
Gender		Male	47	45.2%
	104	Female	57	54.8%
Age		18-20 years	5	4.8%
		21-25 years	43	41.3%
	104	26-30 years	25	24%
		31+ years	31	29.8%
School of practice		Rural Day School	18	17.5%
		Urban Government	59	57.3%
	104	Urban Private	10	9.7%
		Mission School	16	15.5%

ITEMS	n =	DESCRIPTION	REQUENCY	PERCENTAGE
Institution		a	49	48.5%
	105	b	52	51.5%
Level taught		Form 1	39	37.1%
		Form 2	47	45.2%
	104	Form 3	18	17.3%
		Form 4	0	0%

The pre-service teachers' ages have been discussed in section 4.3.1 above. However, there were slight differences in the age frequencies between tables 4.3 and 4.4 even though it was the same group of participants. The following reasons explain the differences:

(i) It could be that during the first questionnaire, some pre-service teachers were around 20 years old, for example and the 18 to 20-year range had a frequency of 13 but when they were doing TP, they would have turned 21, which meant that this age category changed and the frequency dropped to five in table 4.4.

(ii) Some student teachers could not be located during TP, thus the number dropped from 120 to 105 (some pre-service teachers could have been posted to remote schools that were not easily accessible to the researcher). This also affected the frequencies of the age ranges.

Table 4.4 above further shows that most pre-service teachers are deployed in urban areas (67%). As confirmed by the pre-service teachers and mentors' interviews, most pre-service teachers were assigned to teach form 1 and 2 classes. This somewhat bias allocation of junior secondary forms to pre-service teachers is illustrated by 82.3% of the participants in this study who indicated that they were teaching forms 1 and 2. The reasons for this predisposition shall be clarified later in the study.

4.3.3 Questionnaire 3

Table 4.5: Mentor teachers' responses

ITEMS	n =	DESCRIPTION	FREQUENCY	PERCENTAGE
Academic qualifications (40)		B.Ed.	5	12.5%
		Degree + CE	9	22.5%
	40	Degree without CE	4	10%
		Diploma/CE	21	52.5%
		Other	1	2.5%
Gender (40)	40	Male	18	45%
		Female	22	55%
Age (40)		22-30 years	3	7.5%
	40	31-40 years	14	35%
		41-50 years	15	37.5%
		51+ years	8	20%
School of practice (40)	40	Rural day school	1	2.4%
		Urban government	36	85.7%
		Urban private	3	7.1%
		Mission school	-	-
Teaching experience		0-3 years	1	2.5%
	40	5-10 years	12	30%
		11-20 years	11	27.5%
		Over 20 years	16	40%
Mentoring experience		0-3 years	11	28.2%
	40	4-7 years	11	28.2%
		8-10 years	3	7.7%
		Over 10 years	14	35.9%

Results from table 4.5 show that most mentors were experienced teachers (97.5% had over 5 years' experience) and were mature (92.5% were over 30 years old). A reasonable number of novice mentors (0-3 years) were also found in the study (28.2%). A few of the teachers had many years teaching experience but were still

novice mentors. There were also mentors with 0 to 3 years' teaching experience and mentors without a teaching qualification. In the sample, 10% (n = 40) of the mentors did not have a teaching qualification but the majority of the mentors in the study had a diploma or certificate. It was difficult to imagine how the mentors without a teaching qualification could provide adequate support to the pre-service teachers they were mentoring.

4.4   Quantitative data analysis

The responses from the questionnaires were presented and analysed on a 5-point Likert scale using descriptive statistics, the chi-square test, paired samples test, paired samples correlation and factor analysis as it is detailed in the sections 3.6.1.1 to 3.6.1.3 of chapter 3.

4.5   Assessment of research questions

4.5.1 Research question 1

The findings in this section sought to answer the question:

> What are the expectations of "learning to teach" by pre-service teachers at two Zimbabwean colleges of education prior to going on teaching practice?

Table 4.6 below illustrates the statistics for the pre-service teachers' expectations about their pedagogical competence, teaching, classroom management and relationships with mentors and learners prior to teaching practice. The data for this table were generated from the first questionnaire.

Table 4.6: Expectations of teaching before teaching practice (from questionnaire 1)

		frequency n =	D	N	A			
	Expectations about teaching					**Mean**	**S.D.**	**Mode**
7.	I can organise a lesson to boost student learning	118	0.8%	9.3%	89.8%	4.28	.665	4
8.	I know how to manage my classroom during lessons	118	3.4%	28%	72%	3.91	.773	4
9.	I know how to deal with students' misconceptions and understandings	118	7.6%	31.4%	61%	3.65	.820	4

		frequency n =	D	N	A	Mean	S.D.	Mode
	Expectations about teaching					**Mean**	**S.D.**	**Mode**
10.	I can adjust my way of teaching on the basis of what students have grasped	119	2.5%	8.4%	89.1%	4.24	.745	4
11.	I will be able to adjust my styles of teaching to suit various learners	117	3.4%	6%	90.6%	4.37	.750	5
12.	I can choose good teaching strategies to direct students' learning in mathematics.	120	3.3%	10.8%	85.8%	4.20	.763	4
13.	I can select appropriate teaching resources that improve my teaching strategies for a mathematics lesson	120	4.2%	16.7%	79.2%	3.99	.855	4
14.	Knowing about different approaches means I can use them for teaching	119	18.4%	26.9%	54.6%	3.59	1.061	4
15.	Using a variety of approaches to teach a mathematical concept may confuse students	119	54.7%	15.1%	30.2%	2.66	1.297	2
16.	I will be able to utilise the skills and techniques gained in college during teaching practice	118	4.2%	5.9%	89.8%	4.28	.856	4
17.	I will be able to relate very well with the students during teaching practice	119	1.7%	19.3%	79%	4.11	.768	4
18.	The teacher must accept students' ideas and propositions	120	2.5%	15.8%	81.7%	4.20	.826	5
19.	I can motivate the students who lack the desire to do mathematics	120	0.8%	7.5%	91.7%	4.33	.650	4
20.	I can assess student learning in various ways	119	4.2%	21.8%	73.9%	3.90	.827	4
21.	Teaching is what I expected in life	119	26.9%	28.6%	44.6%	3.18	1.275	3
22.	A mentor is an expert in teaching mathematics	119	36.9%	38.7%	24.3%	2.85	1.039	3
23.	Mentors create and maintain a welcoming socio-professional context for pre-service	119	19.3%	37%	43.7%	3.30	.988	3

		frequency n =	D	N	A		Mean	S.D.	Mode
	Expectations about teaching						**Mean**	**S.D.**	**Mode**
	teachers								
24.	Mentors are always motivated and enthusiastic about teaching and consistent in all stages of teaching	120	36.7%	45%	18.3%		2.77	.896	3
25.	I hope to learn a lot from my mentor	117	3.5%	6.0%	90.6%		4.28	.764	
	Expectations (Total average)						**3.794**	**0.875**	

4.5.1.1 Factor analysis: Expectations about learning to teach

The factor analysis conducted on the theme "Expectations about learning to teach", re-categorised the 19 items to produce six factors namely, F1-Teaching strategies (5 items), F2-Classroom management (4 items), F3-Relationships with mentors (3 items), F4-Knowledge about learners (3 items), F5-Tools of learning to teach (2 items) and F6-Motivational strategies (2 items). These factors explained 60% of the total variability under this theme. Only the latent variables (items) with coefficients greater than 0.5 were considered for each factor. Results from table 4.7 below show that the coefficients, which are not highlighted imply that we can exclude them from the analysis without losing much information on the theme. Hence, the theme can be approached using only the six factors mentioned above. The means of these categories were calculated and were used to calculate the satisfaction index on the theme.

Table 4.7: Rotated component matrix – Expectations of learning to teach

	Questionnaire Items	**Rotated Component Matrix**					
		Component					
		F1	F2	F3	F4	F5	F6
7	Can organise a lesson to boost learning	0,5181	0,4794	0,1339	-0,1705	-0,3363	-0,0169
8	I know how to manage my classroom during lessons	0,1693	0,7862	-0,0149	0,0584	-0,0252	0,1227
9	Know how to deal with students' misconceptions & understanding	0,0529	0,7738	0,0828	0,1499	0,2120	-0,0937

	Questionnaire Items	Rotated Component Matrix					
		Component					
10	I can adjust my teaching based on students' understanding	0,7012	0,2139	-0,2443	0,0586	-0,0132	0,0311
11	Can adjust my teaching styles to suit various learners	0,7322	0,1531	0,0208	0,0031	0,0758	0,2520
12	Can choose good teaching styles to direct students' learning	0,3691	0,6473	0,0868	0,1168	0,1078	0,1417
13	Can select appropriate teaching resources to improve my teaching strategies	0,5474	0,1610	0,0398	0,4545	0,1234	-0,2023
14	Knowing different approaches means ability to use them	0,0548	0,1220	0,1866	-0,1300	-0,2362	-0,0561
15	A variety of approaches to teach a concept confuses students	0,1258	-0,0758	-0,0918	-0,0041	-0,7622	0,1402
16	Able to use skills gained in college during TP	0,5871	0,0993	0,4862	0,1129	-0,0183	-0,2149
17	Ability to relate well with the students during TP	0,0545	0,2942	0,0790	0,6909	0,2624	0,0542
18	Teacher to accept students' ideas & propositions	-0,0009	-0,0368	-0,0390	0,6889	-0,2238	-0,1330
19	I can motivate students lacking the desire to learn maths	0,1798	0,1204	0,1488	0,5679	-0,0508	0,5163
20	I can assess students' learning in various ways	0,4397	-0,0078	-0,0971	0,2474	0,4818	0,1830
21	Teaching is what I expected in life	0,0442	0,0739	0,0296	-0,0928	-0,0365	0,8821
22	A mentor is an expert in teaching maths	0,1280	-0,2394	0,6581	-0,1335	0,2124	0,1254
23	Mentors create a welcoming socio-professional context for pre-service teachers	-0,1409	0,1494	0,8287	0,0199	0,1189	-0,0300
24	Mentors are always motivated about teaching	-0,0370	0,1575	0,7805	0,1538	-0,0982	0,0625
25	I hope to learn a lot from my mentor	0,2749	0,1710	0,1528	-0,1824	0,5045	0,0699
	Average	**0.6172**	**0.7358**	**0.7558**	**0.6492**	**-0.1289**	**0.6992**
	Grand average (Av)						**0.5910**

124

$$\text{Satisfaction Index} = \frac{Av - |a|}{|A| - |a|} = \frac{0.5910 - 0.1289}{0.7558 - 0.1289} = 73.7\%$$

The index of 73.7% calculated above highlights positive expectations about "learning to teach" before teaching practice. The satisfaction rate confirms and relates well with a mean of 3.794 calculated in table 4.6, both representing "agree" on the Likert scale. The implication of this finding is that pre-service teachers were positive about and agreed with the issues raised under the theme "expectations of learning to teach".

Findings in table 4.6 and table 4.7 indicate that an overwhelming majority of the pre-service teachers were sure-footed that they would be able to manage their classes effectively, present lessons with minimal problems and have warm relationships with their pupils, as reflected by the means of the responses that were in the range 3.91 to 4.37 demonstrating a strong agreement. Their expectations before TP were positive about "learning to teach" mathematics during TP. This is consistent with findings from studies by Tarman (2012) and Gan (2013), which established that most pre-service teachers feel that they know what good teaching is and that they expect to relate to their students well and to practice in an atmosphere conducive to learning. They expect to present the subject in a unique way using the most appropriate strategies. Hence, they enter the profession with high expectations about the teaching and learning of mathematics (Nicol & Crespo, 2003). However, the results illustrate that pre-service teachers were not sure or did not have confidence in their future mentors as indicated by the percentages below 50% (items 22, 23, 24 of questionnaire 1).

4.5.1.2 The chi-square test to show the association between pre- service teachers' demographic data and their expectations in table 4.6

The chi-square test findings showed that the rest of the responses were independent of the pre-service teachers' demographic data ($p>0.05$), save for those listed in table 4.8 below. The study was only interested in variables that had an influence on the participants' responses ($p<0.05$).

Table 4.8: Results of the chi-square test for table 4.6

Item	Gender (p value =)	Age (p value =)	High school attended (p value =)	Institution (p value =)	Teaching experience (p value =)
7		0.00			
8	0.001			0.039	0.004
9				0.003	
12		0.013	0.037	0.028	
16		0.037		0.041	
17				0.011	
20			0.047		
21			0.022		

From the results displayed in table 4.8 above, only the pre-service teachers' expectations of classroom management (item 8) were influenced by their teaching experience prior to joining the college, as reflected by $p = 0.004$. All the pre-service teachers who had 3 years or more of teaching experience before joining the college agreed that they knew how to manage their classes, 90.7% in the 1 to 3 years' range agreed with the same issue and only 59% of those who had never taught agreed (appendix 7A). This implies that the more experienced the pre-service teacher was before TP, the more they were agreeable to the ability to manage their classes. This is similar to findings by Unal and Unal (2012) that indicate that classroom management is a skill that is gained through teaching experience. This suggests that years of experience prior to TP had an impact on their decisions about classroom management.

The results also show that the institution that the pre-service teachers attended appears to play a pivotal role in their decisions about their pedagogical competence and classroom management (items 8, 9, 12, 16, 17). Similarly, Oliver and Reschly (2007) argue that the improvement of classroom management normally requires a systematic approach to teacher preparation. In addition, he notes that highly effective instruction before TP reduces, but does not fully eliminate, classroom problems. Therefore, the fact that some participants could have received effective

instruction that encouraged professional engagement may have guided their decisions on pedagogical competence and classroom management.

4.5.2 Research question 2

This section presents findings on the question:

> What do the pre-service teachers reportedly learn about mathematics during teaching practice?

4.5.2.1 Pre-service teachers' views

Table 4.9 below summarises the results of pre-service teachers' views regarding the mathematics content they learn during teaching practice.

Table 4.9: Pre-service teachers' mathematics content knowledge during teaching practice (Questionnaire 2)

NO	ITEMS	N =	D	N	A	Mean	S.D.
57	The course work material covered enough content that helped me to teach well during teaching practice	104	24.1%	7.7%	68.3%	3.57	1.275
58	I have adequate knowledge about the mathematics content I teach	105	8.6%	9.5%	81.9%	4.10	0.96
59	I can think mathematically	105	1%	18.1%	80.9%	4.17	0.753
60	I have different ways of improving my understanding of mathematics	104	1.9%	5.8%	92.4%	4.24	0.646
61	"A" level mathematics content is enough for a teacher to teach up to "O" level	103	17.5%	17.5%	65%	3.78	1.22
63	The mathematics content in the classes that I teach is difficult	105	81.9%	8.6%	9.6%	1.83	1.033
64	After qualifying as a teacher, I will prefer to teach mathematics at junior level (Forms 1 & 2)	103	61.2%	14.6%	24.3%	2.4	1.294
65	After qualifying as a teacher, I will prefer to teach mathematics at "O" level (Forms 3 & 4)	104	9.6%	15.4%	75%	4.10	1.128
	Total average					**3.524**	**1.039**

Findings from table 4.9 above indicate that pre-service teachers were satisfied with the mathematics content knowledge they had, as shown by the mean scores that are all above 3.5. Items 63 and 64 demonstrate negative means of 1.83 and 2.64

respectively. The implication of this finding is an indication of positive responses in relation to their mathematics knowledge. Livy, Vale and Herbert (2016) maintain that successful teachers need to be conversant with the mathematics appropriate to the level they teach. Failure to have enough content for teaching may have a negative impact on the pre-service teacher's performance. McDiarmid and Ball (1998) contend that teachers cannot effectively teach what they do not know. My findings imply that it is critical that pre-service teachers are acquainted with the content knowledge of the mathematics subject levels they expect to teach. This finding is similar to the conclusion by Ball *et al.* (1988) in the teacher education and learning to teach (TELT) study that teachers with more content knowledge tend to emphasise the conceptual, problem solving or inquiry aspects of their learners when compared to those with less content. Both conclusions suggest that pre-service teachers' subject content knowledge shapes the way they teach and the impact that they have on their learners' outcomes.

4.5.3 Research question 3

The purpose of the question, "What do the pre-service teachers reportedly learn about mathematics teaching during teaching practice?" was to collect quantitative data that would shed light on pre-service teachers' classroom experiences regarding their teaching strategies, classroom management, relationships with learners, assistance from the school and college, amongst others, to boost their teaching during teaching practice. The data was collected from the second questionnaire.

4.5.3.1 Classroom experiences

Table 4.10: Classroom experiences during teaching practice (Questionnaire 2)

		n =	D	N	A			
	Experiences during teaching practice					**Mean**	**S.D.**	**Mode**
7.	The college has done well to prepare me for the classroom	105	8.6%	8.6%	82.9%	4.16	0.911	5
8.	I am confident to teach mathematics	105	-	3.8%	96.2%	4.69	0.543	5
9.	My classroom management skills are quite appropriate	105	2.9%	12.4%	84.7%	4.1	0.714	4
10.	I have an understanding of how	100	31.0%	22%	75.0%	3.97	0.771	4

	Experiences during teaching practice	n =	D	N	A	Mean	S.D.	Mode
	students learn mathematics							
11.	I can apply different teaching approaches during lessons at the appropriate time	103	3.9%	8.7%	87.4%	4.21	0.762	4
12.	Using a variety of approaches to teach a mathematical concept may confuse students	105	58.1%	12.4%	29.5%	2.64	1.381	2
13	Knowing about different approaches means I can use them for teaching	101	17.8%	7.9%	74.2%	3.78	1.18	4
14.	I use the textbook quite often during my lessons	104	13.5%	23.1%	63.5%	3.75	1.068	4
15.	I can select appropriate teaching resources that enhance my teaching approaches for a mathematics lesson	104	-	9.6%	90.4%	4.28	0.63	4
16.	Teaching practice has given me an opportunity to experiment with teaching approaches covered theoretically at college	105	2.9%	1.0%	96.2%	4.52	0.708	5
17.	I got a lot of insight on how students learn mathematics during teaching practice	105	1.0%	6.7%	92.4%	4.39	0.658	5
18.	It is quite easy to utilise the skills and techniques gained in college during teaching practice	103	16.5%	22.3%	61.1%	3.62	1.021	4
19	I can motivate students who lack the desire to do mathematics	105	3.9%	6.7%	89.5%	4.24	0.779	4
20.	There is a sound relationship between myself and my students	105	3.8%	8.6%	87.7%	4.3	0.786	5
21.	I am concerned about my ability to meet the needs of slow learners	103	5.8%	13.6%	80.4%	4.11	0.917	4
22.	I can adjust my styles of teaching to suit various learners	102	1.0%	12.7%	86.3%	4.31	0.731	5
23.	I give remedial work every time students have difficulties in grasping a concept	104	11.5%	20.2%	68.3%	3.9	1	4
24.	I respect and accept students' thoughts and suggestions	105	-	9.5%	90.5%	4.41	0.661	5
25.	I allow students to use their own methods of learning	105	15.3%	21.0%	63.8%	3.63	1.002	4

		n =	D	N	A	Mean	S.D.	Mode
	Experiences during teaching practice					**Mean**	**S.D.**	**Mode**
26.	I can assess and evaluate my students' performance in the classroom	105	2.9%	4.8%	92.4%	4.34	0.782	5
27.	The school is doing enough to assist me during teaching practice	104	19.3%	17.3%	63.5%	3.69	1.278	5
28.	The college is doing enough to assist me during teaching practice	104	10.5%	16.3%	73.1%	3.91	1.053	4
29.	Teaching is what I expected in life	103	24.3%	17.5%	58.3%	3.48	1.356	4
30.	My expectations before teaching practice match my experiences during teaching practice	104	38.5%	24%	37.5%	2.91	1.158	4
	Classroom experiences					**3.973**	**0.910**	

4.5.3.2 Factor analysis: Classroom experiences

I conducted a factor analysis for the 24 items of the theme "experiences of teaching". Experiences of teaching in table 4.10 were re-categorised to produce nine factors (figure 4.1).These factors are F1-motivational strategies (4 items), F2-training college support (2 items), F3-classroom management (3 items), F4-teaching strategies (3 items), F5-pedagogical competence (2 items), F6-knowledge about learners (2 items), F7-impact of TP on teaching mathematics (3 items), F8-practising schools support (2 items) and F9-teaching resources (1 item). These factors explained 69.785% of the total variability under this theme (appendix 7C). For further clarification, these factors are presented as follows:
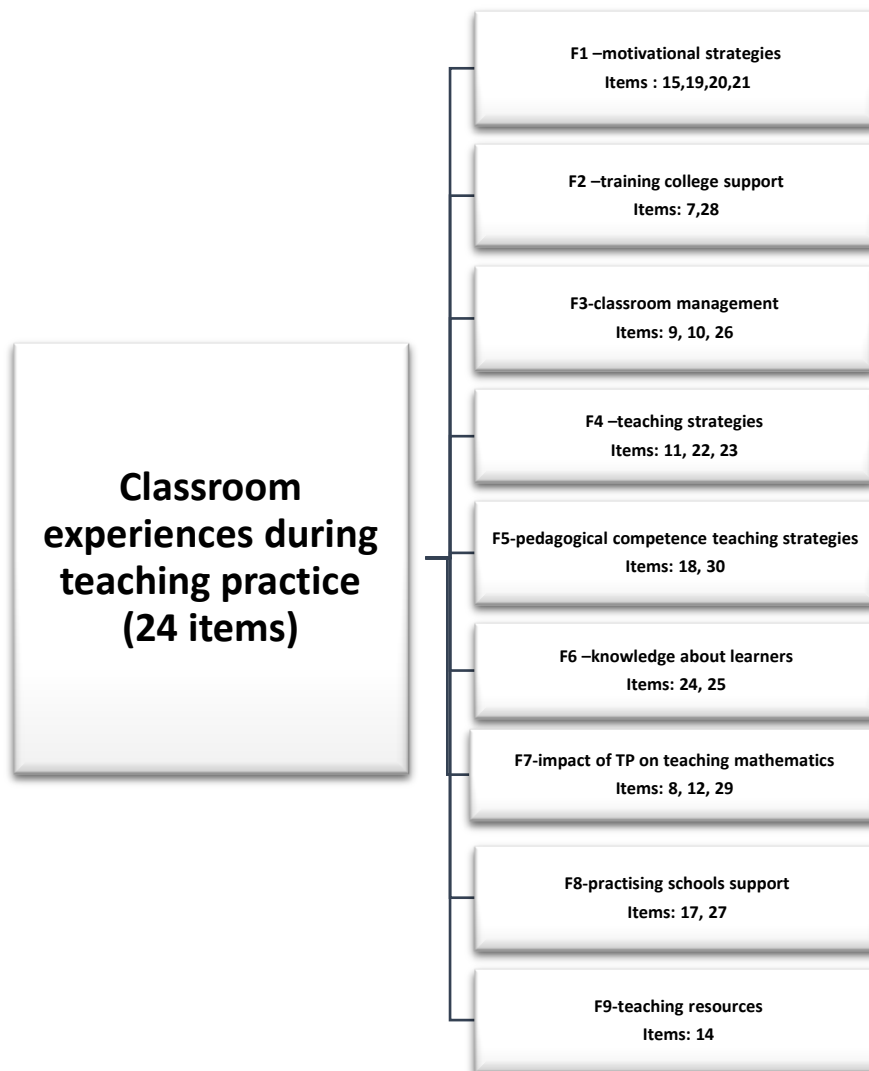
Figure 4.1: Re-categorised (9 items)

The averages of the latent variables were used to calculate the satisfaction index as follows:

Satisfaction Index is $\frac{Av - |a|}{|A| - |a|} = \frac{0.5802 - 0.0210}{0.8592 - 0.0210} = 66.7\%$

This can be interpreted as pre-service teachers' positive classroom practices, which is in line with the results of table 4.10 above, with a mean response of 3.9725 on the Likert scale.

The results indicate that most of the pre-service teachers (66.7%) were satisfied with their classroom experiences during teaching practice as per expectations. The highest mean was 4.69 with a count of 96.2% and a standard deviation of 0.543.

This was given by the probe "I am confident to teach mathematics". Confidence is unlikely to develop where a student teacher is struggling with lesson presentations. Shulman (1986) asserts that a pre-service teacher needs to be empowered with knowledge and skills to be effective during teaching. Effectiveness produces confidence and self-efficacy. The standard deviation of 0.543 implied that the responses were fairly homogeneous. With the exception of items 12 and 30, the lowest mean was 3.48 given by "Teaching is what I expected in life", with a standard deviation of 1.356. Although pre-service teachers had mixed opinions about this issue, as indicated by a relatively high standard deviation, there are reasons to be concerned about the relatively low mean because what prompted participants to be teachers is likely to affect their attitudes towards teaching, hence, influencing the way they teach.

Item 12 has a negative mean of 2.64 (29.5%) but yielded a positive response which indicated that pre-service teachers were using a variety of approaches in their teaching of mathematics concepts. Data from item 30 describe pre-service teachers as less positive regarding the match between expectations prior to teaching practice and experiences during teaching practice, as shown by the low mean of 2.9. The standard deviation is 1.158 which, when read together with the mean (2.9), implies that responses are not homogeneous. However, this is in line with a study by Cole and Knowles (1993) that reported that pre-service teachers' expectations often do not match their actual field experiences.

4.5.3.3 The chi-square test results to show the association between pre-service teachers' demographic data and their classroom experiences

The chi-square test (cross tabulation) was conducted to illustrate the association that exists between pre-service teachers' demographic data and their responses in table 4.10 at 95% level of significance. The results of the test demonstrated that many of the responses were independent of the pre-service teachers' demographic data ($p>0.05$), hence, attention is focused only on those that were influenced by pre-service teachers' demographic details.

Table 4.11: Results of the chi-square test for table 4.10

Item	Gender (p value =)	Age (p value =)	School of practice (p value =)	Institution (p value =)	Level being taught (p value =)
7				0.001	
8	0.002				
10		0.023			
12			0.016		
14				0.02	
21	0.046		0.025		
26					0.023
29				0.034	
30			0.022		

From the statistics exhibited in table 4.11, with a similar pattern to table 4.8, training institutions seem to play a pivotal role in preparing pre-service teachers for classroom practices as indicated by the value of p=0.001 for item 7. The findings show that participants' decisions are shaped by what is taught to them on campus. In addition, the match between expectations and experiences is impacted by the pre-service teachers' school of practice with p value=0.022. Seventy per cent of the pre-service teachers who agreed that their expectations matched their experiences were practising at private schools. Privately owned schools are associated with better resources in the major cities of Zimbabwe (Bowora, 2008). The result could therefore suggest that because of their better resources, privately owned schools in Zimbabwe may be capable of satisfying pre-service teachers' needs during practice in comparison to the public schools.

4.5.3.4 Knowledge about mathematics teaching: Pedagogical content knowledge (PCK) teaching strategies

Table 4.12 summarises the pre-service teachers' concerns about the most effective ways to ensure teaching of mathematics knowledge to the students.

Table 4.12: Pre-service teachers' views

	ITEMS	N =	At least disagree	Neutral	At least agree	Mean	S.D.
51	Knowing mathematics involves the ability to remember formulas and procedures	104	24.1%	22.1%	53.9%	3.33	1.186
52	The textbook is the best resource to use when teaching mathematics	104	31.7%	30.8%	37.5%	3.03	1.092
53	The role of the mathematics teacher is to transmit knowledge and ensure that the learners have received this knowledge	104	16.4%	7.7%	76%	3.85	1.147
54	**Correct answers are more important than the method used to obtain them**	**105**	**83.8%**	**8.6%**	**7.6%**	**1.81**	**0.955**
	Total average					**3.005**	**1.095**

Item 54 has a low mean (mean=1.81) and standard deviation 0.955, showing that pre-service teachers refuted the idea that answers are more important than the method, although they still believed that knowing mathematics involves the ability to memorise formulae (item 51). The means in table 4.12 show positive responses by pre-service teachers to the items (51, 52, 53) as indicated by the mean scores above three. This is consistent with the study by Nicol and Crespo (2003) that most pre-service teachers see teaching as a simple transfer of information to pupils and that teaching is largely based on the teacher and the textbook. However, the responses to these items (51, 52 and 53) are quite polarised as indicated by the high standard deviations (1.186, 1.092 and 1.147 respectively). For example, the responses for item 53 ranges from "disagree" to "strongly agree". The responses are spread across the scale and these extreme cases call for caution when interpreting the results on the pre-service teachers' views about knowledge dissemination to the learner.

4.5.3.5 Practicum experiences with learners

Table 4.13: Practicum experience with learners (from questionnaire 2)

NO	ITEMS N = 105	N =	D	N	A	Mean	S.D.
67	I am fair and objective to learners by including all learners in my lessons	105	1.9%	4.8%	93.4%	4.4	0.674
68	I respect the socio-cultural diversities of learners (religion, gender, ethnicity, language, etc.)	105	1%	2.9%	96.1%	4.52	0.606
69	I know how to deal with stressed students in the classroom	105	1.9%	28.6%	69.5%	3.87	0.735
70	I know how to care and reinforce the well-being of my students	103	1%	15.5%	83.5%	4.11	0.726
	Total average-experiences with learners					**4.225**	**0.685**

Table 4.13 suggests that most of the pre-service teachers rated their relationship with the learners highly concerning the students' welfare in the classroom. The means range between 3.87 and 4.52 and all the standard deviations were less than one. The findings reflect a rather positive approach to teaching that is consistent with the findings by Eisenhardt *et al.* (2012) that pre-service teachers need to be aware that students are different and therefore need to be treated differently. Learners have personal, social and emotional needs, which all influence their learning, thus they need differentiated attention.

4.5.3.6 Mentors' views on pre-service teachers' classroom practices
The study also explored the mentor teachers' perspectives about their mentees.
Table 4.14 presents the views of mentors about the pre-service teachers' classroom practices:

Table 4.14: Mentors' views about pre-service teachers' classroom performance

	ITEM N = 42	N=	At least Disagree	Neutral	At least Agree	Mean	S.D.
16	The college has done enough to prepare pre-service teachers for teaching practice	40	5%	22.5%	72.5%	3.88	0.791
17	My mentee knows the content s/he teaches	40	7.5%	17.5%	75%	3.88	0.911

	ITEM N = 42	N=	At least Disagree	Neutral	At least Agree	Mean	S.D.
18	My mentee's classroom management is very satisfactory	39	10.3%	17.9%	71.8%	3,67	0.838
19	Field experience courses offered in teachers' colleges for pre-service teachers needs to be enhanced in terms of peer teaching	40	2.5%	17.5%	80%	3.95	0.677
20	My mentee often has problems explaining concepts explicitly to the students	40	45%	25%	30%	2.88	0.992
21	My mentee can conceptualise and analyse situations to solve problems	40	7.5%	22.5%	70%	3.73	0.751
22	My mentee can structure lessons to promote students' learning	40	2.5%	5%	92.5%	4.18	0.636
23	My mentee can adjust the way s/he teaches based on what students understand or do not understand	40	5%	25%	70%	3.90	0.841
24	My mentee knows how to develop schemes of work and lesson plans.	40	2,5%	5%	92.5%	4.23	0.660
25	My mentee can select and adapt effective teaching strategies and learning activities	40	5%	17.5%	77.5%	3.88	0.723
26	My mentee is capable of identifying and attending to learners' needs	40	7.5%	17.5%	75%	3.75	0.707
27	My mentee is capable of setting, marking and grading students' achievements using a variety of assessment skills	38	13.2%	10.5%	76.3%	3.79	0.875
28	My mentee can manage time effectively	40	2.5%	27.5%	70%	3.85	0.736
29	My mentee critically reflects on his/her work to improve practice	39	5.1%	20.5%	74.4%	3.79	0.695
30	My mentee can create a conducive learning environment that encourages	40	2.5%	12.5%	85%	4.03	0.660

	ITEM N = 42	N=	At least Disagree	Neutral	At least Agree	Mean	S.D.
	learning in his/her lessons						
31	My mentee is able to adapt to change	40	7.5%	12.5%	80%	3.90	0.778
	Total average					**3.83**	**0.7669**

4.5.3.7 Mentors' views on pre-service teachers' knowledge about mathematics
teaching (items 16 to 21, table 4.14)

The result of the survey shows that mentors' views regarding pre-service teachers' mathematics teaching knowledge were positive (items 16 to 21, table 4.14). All the means range from 3.67 to 3.88 with a percentage count from 70% to 80% (except for item 20). These are relatively high scores, which are clustered around the means as indicated by relatively low standard deviations that are all below one (from 0.677 to 0.992). However, the responses for items 17 and 19 suggest that although pre-service teachers have the mathematics content (item 17), they may still be lagging behind in terms of pedagogy. Hence, they opined that field experience courses offered in teachers' colleges need to be enhanced (item 19 with mean =3.95) in order to refine their performance. With regard to item 20, there were mixed views concerning pre-service teachers' ability to explicitly explain concepts to pupils. Ball *et al.* (2001) suggest that the more content teachers have, the more effective they become, implying that their content knowledge can actually positively assist them in their teaching. The issue of content versus pedagogy is discussed further in the next section 4.5.3.8.

Mentors' views about pre-service teachers' classroom performance (items 22 to 31, table 4.14)

Congruent with the pre-service teachers' opinions about classroom practices (Table 4.10), mentors had a similar view as reflected in their responses to items 22 to 31. Table 4.14 above (items 22 to 31), shows that pre-service teachers are regarded as being skilled in every aspect of teaching. This ranged from the ability to organise and plan and the use of effective strategies of teaching and time management, amongst others. The means ranged from 3.75 to 4.28 with a count of 70% to 92.5% (all the standard deviations are below 1). This may suggest that their college programmes

do well at developing the required skills in the pre-service teachers.

4.5.3.8 Does mathematics content knowledge mean the ability to teach it effectively?

Table 4.15 attempts to answer the question above by presenting pre-service teachers' responses on this subject (items 49 and 50 questionnaire 2).

Table 4.15: Mathematics content knowledge regarding the ability to teach it

ITEM	N =	Disagree	Neutral	Agree
49. Mathematics teaching at "O" Level is more effective if a teacher has more content knowledge	103	(55) 53.4%	(22) 21.4%	(26) 25.3%
50. Knowing mathematics and the ability to teach it cannot be separated	103	(28) 27.1%	(13) 12.6%	(62) 60.2%

From the survey of pre-service teachers who were on teaching practice, 53.4% of the participants refuted the idea that teaching is more effective if a teacher has more content compared to 25.3% who agreed with the idea. However, 60.2% of the pre-service teachers believed that content knowledge could not be separated from the ability to teach it, as indicated in table 4.15 above, against 27.1% who disagreed. A combination of these two ideas suggests that while teachers need content knowledge to teach mathematics, the mathematics content does not enable them to make information accessible to the learners. McDiarmid and Ball (1988) also posit that it is essential that pre-service teachers become acquainted with content knowledge of the mathematics they will teach in a way that they are able to deliver it to the learners. Shulman (1986) has been instrumental in clearly spelling out what teachers need to know with regard to these two constructs, that is, "what to teach" (the content knowledge) and "how to teach" (the pedagogy). However, there is a need to conduct further studies regarding how these constructs are related in the context of Zimbabwe.

4.5.4 Research question 4

How do the pre-service teachers reportedly learn about mathematics and mathematics teaching during teaching practice, that is, what structures, resources and tools are employed during the "learning to

teach" process?

Most of the participating pre-service teachers were assigned to qualified classroom teachers who were supposed to guide and supervise them, as a way of "learning to teach". This is consistent with what Maphosa *et al.* (2007) see as the major expectations on mentors. Mentors need to supervise, guide and instruct the mentees. Mentors contribute to the means and structures through which knowledge is shared with pre-service teachers during "learning to teach". In other words, pre-service teachers learn through interactions with their supervisors, which makes it necessary to look at their practicum experiences with school and college supervisors. The pre-service teachers' experience in schools, on the job interactions and the identification of supportive antecedents has the greatest potential to change pre-service teachers' pre-existing knowledge during training (De Neve *et al.*, 2015).

This section therefore focuses on how mathematics teaching knowledge is shared with the pre-service teachers by their supervisors (school- and college-based).

Table 4.16: Experiences with mentors (extract from questionnaire 2)

ITEM	Experiences with mentors	n	Mean	Std. Deviation
31	A mentor is an expert in teaching mathematics	104	3.29	1.297
32	Mentors are always motivated and enthusiastic about teaching mathematics	104	2.96	1.222
33	My mentor helps me to plan for the lessons	104	2.64	1.307
34	My mentor helps me to decide on the media to use for developing concepts	103	2.47	1.178
35	My mentor helps me to decide on which teaching approaches to use for my lessons	104	2.71	1.220
36	My mentor let me sit in a lesson she was teaching during my TP	104	2.74	1.400
37	My mentor demonstrated some of the teaching approaches before asking me to teach a lesson	104	2.45	1.238
38	My mentor coached me on how to teach	103	2.90	1.287
39	My mentor regularly sits in on lessons that I teach	101	3.07	1.283

	Experiences with mentors			
ITEM		**n**	**Mean**	**Std. Deviation**
40	My mentor allows me to use the teaching methods I feel will be useful	104	4.03	1.038
41	My school-based mentors provide constructive feedback and professional support	104	3.49	1.254
43	My school-based mathematics mentors appropriately model blending content and teaching strategies	104	3.19	1.006
	Total average		**3.00**	**1.227**

The findings in table 4.16 illustrate that pre-service teachers were less positive about the assistance they received from their mentors as shown by the several mean item scores below three. In this regard, Rakicioglu-Soylemez and Eroz-Tuga (2014) concur that there are differences between the definitions of mentoring and the actual practices. If this practice is not monitored, the objectives of teaching practice may not be attained. For items 31, 39, 41 and 43 the means were all above 3, indicating that the pre-service teachers were positive about the issues that were addressed. However, the standard deviations for the same items were high, 1.297, 1.283, 1.254 and 1.006 respectively, suggesting that equally high numbers of participants were positive and negative regarding issues addressed in those items. The highest mean on this theme was 4.03 (82.7% agreed and 8.7% disagreed) given by the statement "My mentor allows me to use the teaching methods I feel will be useful". Such a response could be expected because, according to Kiggundu and Nayimuli (2009) and Maphosa *et al.* (2007), some pre-service teachers are normally on their own in the classrooms during teaching practice. This occurs because some mentors tend to place the burden of teaching on the pre-service teachers without assistance and therefore the pre-service teachers were likely to employ the approaches they wanted. This interpretation was confirmed in the interviews with pre-service teachers in which they affirmed that they were teaching on their own most of the time (section 4.9.1.5).

Responding to open-ended questions about mentors and college supervisors' behaviour towards pre-service teachers during teaching practice, the results from

participants show that the mentors were supportive of the pre-service teachers as indicated in table 4.17. The table also shows the results of mentors' views about pre-service teachers' behaviour during teaching practice.

Table 4.17: Educators' supervisory practices and pre-service teachers' teaching practices.

PSTs' views on Mentors' Supervisory practices. Items 71 -72, Questionnaire 2	f	%	PSTs' views on Lecturers' Supervisory practices. Items 71 -72, Questionnaire 2	f	%	Mentors' views on Pre-service Teachers' practices. Item 38, Questionnaire 3	f	%
Absenteeism	2	2.0	assessment erratic	1	1.0	absenteeism, inadequate work	1	2.8
Don't know	1	1.0	confused	2	2.0	discipline	2	5.6
encouraging	4	4.0	confusing	1	1.0	focused more on files than teaching	1	2.8
lacks content	1	1.0	encouraging	19	18.8	lack of confidence	1	2.8
lazy	16	16.0	intimidating	9	8.9	lack of content	1	2.8
motivating	1	1.0	lazy	1	1.0	lack of cooperation	4	11.1
no trust	1	1.0	not helpful	1	1.0	lack of resources	2	5.6
not supportive	4	4.0	not supportive	2	2.0	no problems	8	22.2
over zealous	1	1.0	rude	4	4.0	not sure of college expectations	2	5.6
rude	8	8.0	smart	1	1.0	poor teaching styles	4	11.1
selfish	4	4.0	supportive	51	50.5	promiscuity	1	2.8
supportive	54	54.0	too demanding	1	1.0	resists advice	5	13.9
too busy	1	1.0	too strict	1	1.0	resists change	2	5.6
trust	1	1.0	undecided	7	6.9	resists duties	1	2.8
undecided	1	1.0				time limitations	1	2.8
Total	**100**	**100**		**101**	**100**	**Total**	**36**	**100**
missing	**5**		**missing**	**4**		**missing**	**6**	
Total	**105**		**Total**	**105**			**42**	

Frequencies for themes emerging from the responses on open-ended questions in questionnaires 2 and 3

4.5.4.1 Pre-service teachers' views about mentors' behaviour

Table 4.17 shows that regardless of whether pre-service teachers appreciate the

support and encouragement they received from their mentors, they noted some negative practices such as the mentors' laziness, rudeness, selfishness and absenteeism among other things.

4.5.4.2 Pre-service teachers' views about college supervisors' behaviour

The results from table 4.17 also depict that college supervisors were perceived as supportive and encouraging. However, a small percentage of pre-service teachers felt intimidated by their lecturers (8.6%) when they visited during teaching practice. The percentage could be higher (compared to the other attributes) if "rudeness, strictness and intimidation" are combined to give 13.4%. Some were said to be confused, too demanding and their assessments were erratic. Some pre-service teachers explained that lecturers approached them with different ideas on the same issues, which was construed as confusion and indecisiveness. According to Rosemary, Richard and Ngara, (2013), the supervisors' lack of consensus in dealing with similar issues is a variable that affects the efficacy of TP supervision. However, the counts show that the supervisors' positive behaviour (69.4%) outweighed the negative behaviour (28.8%).

4.5.4.3 Mentors' views about pre-service teachers' behaviour

When mentors were asked to explain, in the open-ended questions, the problems that they faced with pre-service teachers on teaching practice, the main issues that were raised included pre-service teachers' resistance to advice (13.9%), a lack of cooperation (11.1%) and poor teaching styles (11.1%) among others, as shown in table 4.17 above. However, these responses from the open-ended questions contradicted the results of table 4.14 where mentors labelled pre-service teachers as nearly perfect in their teaching and sound relationships.

Table 4.18: Mentors' views on TP supervision

ITEM	N =	Disagree	Neutral	Agree
14. I have received enough training to be an effective mentor	40	(8) 20%	(11) 27.5%	(21) 52.5%
15. I gained my skills and expertise in mentoring through experience	39	(0) 0%	(7) 17.9%	(32) 82.1%

The numbers in brackets represent the frequencies of participants who responded in a particular way. Table 4.18 above displays the results of the survey on school based-mentors regarding their training for teaching practice supervision (items 13 and 14 on the mentors' questionnaire). The results of the survey show that although 52.5% of the mentors received training for teaching practice supervision, a significant number (20%) did not receive training. Given the standard deviation of 1.176, the results reflect a wide range of mixed feelings among the mentors. In addition, 82.1% gained their expertise to supervise pre-service students during teaching practice through experience and not through training. Hurrell (2013) explains that experience does not equate to expertise, implying that spending a number of years practising as a mentor does not mean being highly skilled in mentoring. Hamaidi *et al.* (2014) hence suggest that meetings and workshops for teacher educators should be conducted so that they become aware of what is expected of them during TP supervision.

4.5.5 Research question 5

This section seeks to answer the question:

> "What are the differences between the pre-service teachers' expectations and what they reportedly learn during teaching practice?"

Table 4.19 juxtaposes the expectations prior to teaching practice and the experiences during teaching practice on the items that tested the same skills, in order to detect the changes that took place through exposure to the teaching practice period. This also gave insights on the impact of teaching practice on the pre-

service teachers' expectations regarding the application of teaching skills and competence in teaching.

Table 4.19: Comparison of expectations and experiences of teaching practice

	Expectations of learning to teach before teaching practice				Classroom experiences during teaching practice		
	Expectations	Mean	S.D.		Experiences	Mean	S.D.
8	I know how to manage my classroom during lessons	3.91	.773	9	My classroom management skills are quite appropriate	4.10	.714
9	I know how to deal with students' misconceptions and understanding	3.65	.820	10	I have an understanding of how students learn mathematics	3.97	.771
10	I can adjust my teaching based on students' understanding	4.24	.745	22	I can adjust my teaching styles to suit various learners	4.31	.731
11	I will be able to adjust my styles of teaching to suit various learners	4.37	.750	22	I can adjust my teaching styles to suit various learners	4.31	.731
12	I can choose good teaching styles to direct students' learning	4.20	.763	11	I can apply different teaching approaches during lessons at appropriate times	4.21	.762
13	I can select appropriate teaching resources to improve my teaching strategies	3.99	.855	15	I can select appropriate teaching resources that enhance my teaching	4.28	.630
14	Knowing different approaches means the ability to use them	3.59	1.061	13	I know about different approaches which means I can use them for teaching	3.78	1.180
15	A variety of approaches to teach a concept confuses students	2.66	1.297	12	Using a variety of approaches may confuse students	2.64	1.381
16	I will be able to use skills gained in college during TP	4.28	.856	18	It is quite easy to utilise skills gained in college during TP	3.62	1.021
17	I am able to relate well with the students during TP	4.11	.768	20	There is a sound relationship between myself and students	4.30	.786
18	The teacher should accept students' ideas and propositions	4.20	.826	24	I respect and accept students' thoughts and suggestions	4.41	.661
19	I can motivate students	4.33	.650		I can motivate	4.24	.779

	Expectations of learning to teach before teaching practice				Classroom experiences during teaching practice		
	Expectations	Mean	S.D.		Experiences	Mean	S.D.
	lacking the desire to learn maths			19	students who lack the desire to do mathematics		
20	I can assess students' learning in various ways	3.90	.827	26	I can assess and evaluate my students' performance in the classroom	4.34	.782
21	Teaching is what I expected in life	3.18	1.275	29	Teaching is what I expected in life	3.48	1.356
	Expectations	3.90	.876		Experiences	3.99	.889

Whilst table 4.19 shows that students' expectations of "learning to teach" matched their experiences during teaching practice as indicated by the means 3.9 and 3.99 respectively, it is possible that the results could have been affected by other factors. For example, since it is the same group of students who answered the first and second questionnaires, there may be a tendency to replicate the same answers in order not to contradict themselves. However, the fact that the instruments were administered several months apart and some of the questions were worded slightly differently reduces the possibilities for such contamination.

Interestingly, however, is the way pre-service teachers responded differently to item 16 before teaching practice (mean = 4.28) and item 18 during teaching practice (mean = 3.62), which states: "It is quite easy to utilise skills gained in college during teaching practice". Their responses regarding their ability to use skills gained in college during teaching practice were conspicuously different, decreasing from 89.8% to 61.1%, as depicted on the graph below:
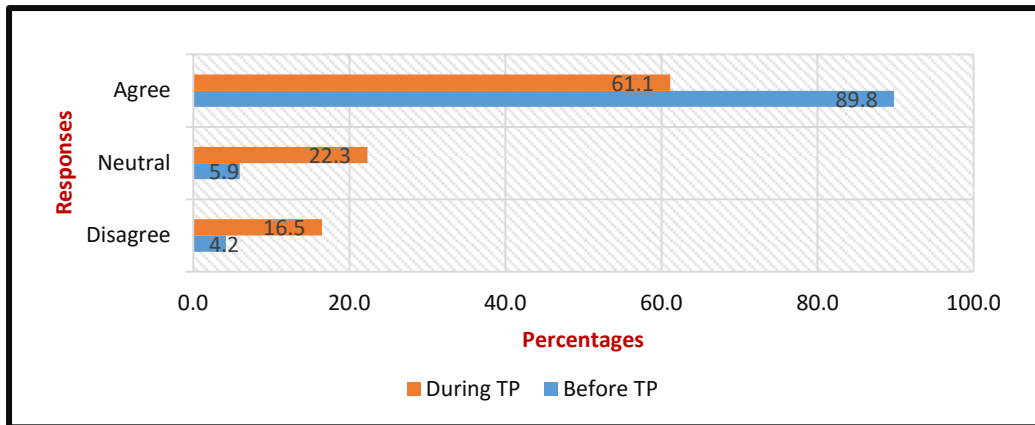
Figure 4.2: It is easy to utilise the skills gained in college during TP

The difference suggests that they may have over-estimated their ability to apply learned skills in the classroom setting before teaching practice. This is in line with the findings by Tarman (2012) that sometimes pre-service teachers discover that what they know about teaching and schooling is divorced from their actual experiences during teaching practice.

Contrary to item 21, a significant number of pre-service teachers' responses on item 29 from table 4.19 also indicated that teaching is the career they expected. Table 4.20 that follows shows the views of pre-service teachers on this issue before and during teaching practice.

Table 4.20: Teaching is what I expected

ITEM	N =	Disagree	Neutral	Agree
21. Teaching is what I expected in life: Before teaching practice	119	(32) 26.9%	(34) 28.6%	(53) 44.6%
29. Teaching is what I expected in life: During teaching practice	103	(25) 24.3%	(18) 17.5%	(60) 58.3%

From Table 4.20, the results show that teaching practice had an impact on the pre-service teachers' attitude or perception towards the teaching profession. The difference in participants accepting "teaching" as a profession that they expected in life, was conspicuous. The percentage increased from 44.6% before teaching practice to 58.3% during teaching practice. The mean also increased from 3.18 (before teaching practice) to 3.48 (see table 4.19).

4.5.6 Research question 6

4.5.6.1 Statistical analysis of the experiences of "learning to teach" from teaching practice and expectations before teaching practice

At first glance, from table 4.19, it appears that the pre-service teachers' expectations about classroom practices before teaching practice matched their classroom experiences during teaching practice (mean = 3.90 and 3.99 respectively). However, the match needed to be confirmed by the paired samples test that was conducted to establish the significance of the differences between the means before TP and during TP at 95% level of significance.

Table 4.21: Paired samples correlations

		N	Correlation	Sig.
Pair 1	Expectations of learning to teach before teaching practice and classroom experiences during teaching practice	14	**.848**	**.000**

From the above table, it is evident that expectations of "learning to teach" before teaching practice and classroom experiences during teaching practice are highly and positively correlated (0.848) and the correlation is significant (*p*-value=0.000).

Table 4.22: Paired samples t-test

		Paired Differences		t	df	Sig. (2-tailed)
		Mean	Std. Deviation			
Pair 1	Expectations of learning to teach before teaching practice - classroom experiences during teaching practice	-.09857	.26878	-1.372	13	**.193**

H$_0$: $\mu_D = 0$

H$_1$: $\mu_D \neq 0$

Where, μ_D is the difference of means of expectations of "learning to teach" before teaching practice and classroom experiences during teaching practice.

Since $p-value = 0.193 > 0.05$, we fail to reject H_0 and conclude that at 5% level of significance, there is insufficient evidence to say that expectations of "learning to teach" before teaching practice are different from classroom experiences during teaching practice. Hence, pre-service teachers' expectations of "learning to teach" were closely related to their experiences during teaching practice.

4.6   Qualitative findings

The study was based on the premise that collecting data using mixed methods provides a comprehensive response on the research problem. The results or findings from the qualitative approach thus may confirm or refute the quantitative results above, which may enhance the validity and reliability of the study. Creswell *et al.* (2013) agree that a mixed method approach converges or confirms findings from various data sources. This section presents findings of the data collected through focus group interviews that were conducted with the pre-service teachers on teaching practice and mentor teachers. Results of the semi-structured interviews with the college supervisors are also examined in this section.

For ethical considerations, responses are reported confidentially and only pseudonyms/codes were used to refer to the participants. Codes are also used in place of schools and colleges that were involved in the study. The tables below present the pseudonyms and codes that were used during the interviews.

Table 4.23: Pre-service Teachers' Pseudonyms and Codes

Participants: Pre-service teachers		
School	Focus group interview	pseudonyms
QE	1	A1, A2
AW	2	A3, A4
HAT	3	A5, A6,
ABC	4	R1, R2, R3, R4, R5, R6, R7, R8
BCD	5	P1, P2, P3
CDE	6	Q1, Q2
DEF	7	T1, T2, T3

In the analysis, a participant would be referred to in relation to his/her focus group interview (FGI) or just his/her name (not the real name). For example, pre-service teacher A4 in FGI 2 was referred to as FGI2, A4, or just A4.

Table 4.24: Mentors' pseudonyms and codes

Participants: Mentors		
School	Focus Group Interview	Pseudonyms
OB	1	M1, M2
ER	2	M3, M4
MP	3	M5, M6, M7, M8, M9, M10
QE	4	M11, M12, M13
AW	5	M14

Some of the codes allotted to mentors coincided with the pre-service teachers' pseudonyms, for example, there was an A3 student teacher and A3 mentor. The mentors' codes were then slightly changed to avoid confusion of names without changing their contribution in the interview discussions. The mentors' names bearing an "A" code were changed to "M". For example, mentor A1 would be M1, A2 changed to M2 and so forth. These codes are used consistently throughout the study.

The initial intention was to have five participants in each focus group interview for pre-service teachers. However, this was not practical because the interviews were held during the examination period and some pre-service teachers and mentors were not available. In addition, there were few student teachers/mentors who were deployed in some schools and it was impossible to bring them together from different schools to form a group. Aspects such as transport, time and willingness to travel, among others also affected the size of the focus groups. In some cases, the heads of schools denied them permission to attend the interviews outside the school premises. The researcher could thus only mobilise those who were present to form a group, which is the reason why some groups were small compared to others. As a result, instead of having 5 focus group interviews as initially planned, 7 groups were interviewed to boost the numbers, yielding 22 pre-service teacher participants (instead of the proposed n = 25). Five focus group interviews for mentors with 14

participants were conducted. Seven college lecturers participated in the semi-structured interviews and were coded Lecturer 1, Lecturer 2 up to Lecturer 7. The two teachers' colleges involved in the study were coded "a" and "b".

4.6.1 Emerging themes from the interviews

Table 4.25 below summarises the categories, themes and sub-themes that emerged from the data collected during the research interviews.

Table 4.25: Summary of categories, themes and sub-themes from interviews

	RESEARCH QUESTIONS	THEMES	SUB THEMES	CATEGORIES
1.	What are the expectations on "learning to teach" by pre-service teachers at two Zimbabwean Colleges of Education prior to going on teaching practice?	1.1 Expectations about learning to teach (instructional expectations and mentoring practices expectations)	1.1.1 Expectations about teaching practice.	1.1.1.1 Views about "learning to teach" through practice.
			1.1.2 Expectations about pedagogical competence in mathematics teaching	1.1.2.1 Teaching strategies
			1.1.3 Expectations about classroom management	1.1.3.1 Expectations about classroom management
			1.1.4 Expectations about experiences with supervisors and learners.	1.1.4.1 Practicum experiences with mentors and learners.
2	What do the pre-service teachers reportedly learn about mathematics during teaching practice?	2.1 Views about mathematics content knowledge	2.1.1 Views about pre-service teachers' mathematics content knowledge	2.1.1.1 Views about the mathematics pre-service teachers teach in schools
				2.1.1.2 Views about the mathematics pre-service teachers learn in colleges.
			2.1.2 Course structure.	2.1.2.1 Content taught/learnt in college and schools
3.	What do the pre-service teachers reportedly learn about mathematics teaching during teaching practice?	3.1 Experiences about mathematic teaching during TP	3.1.1 Pedagogical competence/classroom practices	3.1.1.1 Teaching approaches
				3.1.1.2 Time management
				3.1.1.3 Lesson preparation

	RESEARCH QUESTIONS	THEMES	SUB THEMES	CATEGORIES
			3.1.2 Challenges of mathematics teaching	3.1.2.1 Pre-service teachers' disciplinary issues
			3.1.3 Professional development	3.1.3.1 Experiences with supervisors/educators
4.	How do the pre-service teachers reportedly learn about mathematics and mathematics teaching during teaching practice, that is, what structures, resources and tools are employed during the "learning to teach" process?	4.1 Tools, resources and structures employed to facilitate "learning to teach mathematics"	4.1.1 Staff development strategies	4.1.1.1 Pre-service teachers' preparation for TP
				4.1.1.2 Mentors' preparation for TP supervision
				4.1.1.3 College supervisors' preparation for TP supervision
			4.1.3 Resources for teaching mathematics	4.1.3.1 Job resources – autonomy
				4.1.3.2 Teaching resources
5	What are the differences between the pre-service teachers' expectations and what they reportedly learn during teaching practice?	**5.1** Differences between pre-service teachers' expectations and experiences of "learning to teach	5.1.1 Pedagogical content knowledge gained by pre-service teachers on TP	5.1.1.1 (a) Classroom management (b) Teaching styles (c) Teaching tools (d) Lesson preparation
			5.1.2 Mentoring practices by college supervisors and mentor teachers.	5.1.2.1 Supervision practices by college lecturers
				5.1.2.2 Supervision practices by mentor teachers
			5.2.1 New beliefs and perceptions about teaching as a profession	5.2.1.1 Pre-service teachers' beliefs about teaching mathematics before and during TP
6.	What suggestions and recommendations can be made to improve the experiences of "learning	6.1 Suggestions and recommendations to improve TP	6.1.1 TP supervision	6.1.1.1 Relationships between pre-service teachers and their supervisors

	RESEARCH QUESTIONS	THEMES	SUB THEMES	CATEGORIES
	to teach" for the mathematics pre-service teachers?			6.1.1.2 Supervision of pre-service teachers
			6.1.2 Staff development programmes	6.1.2.1 Staff development programmes for supervisors and pre-service teachers
			6.1.3 Review of the mathematics taught in colleges	6.1.3.1 Review of the mathematics taught in colleges
			6.1.4 Working conditions	6.1.4.1 Working conditions

4.7   Theme 1: Expectations about learning to teach

Theme 1 focuses on expectations about teaching practice, pedagogical competence in mathematics teaching, classroom management and experiences with supervisors and learners during TP. Yilmaz (2011) confirms that pre-service teachers' beliefs, attitudes, practices, conceptions and expectations should be considered in order to improve educational practices and to prepare pre-service teachers for actual teaching experiences.

4.7.1 Expectations about teaching practice (TP)

4.7.1.1 Views about "learning to teach" through practice

Responding to the question that required participants to explain their views before teaching practice and the manner in which their views had changed (item 6), the responses show that the pre-service teachers' expectations about teaching practice were positive. This supports the quantitative result which had a response mean of 3.7939 (table 4.6) on the Likert scale, indicating that they were expecting to do well in most of the classroom practices during TP. More than 50% of the participants anticipated teaching practice to be easy, straightforward and to be a time of relief from the stress on campus. Some were actually shocked how the students differed and how they needed to be taught differently. This is how some of the pre-service teachers expressed their feelings:

R6**:**   I thought teaching practice would be easy. However, now I realise that it is

very complicated because there are a number of unexpected things that I am going through… students want to be taught in different ways, they come from different homes and they want to be taught differently… It requires a lot of preparation and commitment…

R2:   I was told that teaching practice was time to relax but now I realise that it is a time that requires too much effort and dedication in terms of lesson preparation, lesson plans and evaluating lesson plans**.** There is no time to relax as I thought. At college we thought when you go on TP, the course is finished. It's like you will find things easy since assignments at college were tough. It's just the opposite.

The responses point to a number of similar expectations that the participants had concerning teaching practice (TP). They were of the opinion that all students were similar and approached lessons in a similar manner. Such expectations may have conditioned the pre-service teachers to approach the TP period with relaxed attitudes. The responses show that lesson preparation, against their expectations, was very demanding for the pre-service teachers. The findings are in line with the sentiment of Cole and Knowles (1993) that pre-service teachers view teaching practice as easy to accomplish but they are disillusioned when it proves to be the opposite.

4.7.2 Expectations about pedagogical competence in mathematics teaching

4.7.2.1 Teaching strategies

Reflections from pre-service teachers illustrated that they expected mathematics lessons to be easy to prepare according to the way they were taught at college. The quantitative result also showed that at least 85.8% were positive (items 10, 11, 12) about the ability to use different teaching styles that suit students' ability. As a result, student teachers on teaching practice (TP) seemed to have overestimated the students' learning needs and ability and instead of covering the planned work in a given time, they realised they would need more time to cover the planned work at the end of each lesson. This implies that the teaching approaches they used may have failed to match the topics taught, the amount of work that was planned and the learners' aptitudes. The following selected reflections from the participants proclaim the pre-service teachers' understanding of their lived experiences on this issue:

A6:   My view was that, pupils' understanding would be better. However, the reality in the classroom revealed to me that for each topic, although I thought it was easy, when they wrote the individual work, they would give different answers on the same question. I expected them to perform the same… so, yah, it's not that easy. You don't know how to teach them in order to understand.

A5:   Or else you go with a chart, you think they will quickly understand what is on the chart, then you realise sometimes you need concrete things like when you choose media. Say I am doing area, I say, side by side. Sometimes you need to go with something like a tile then you show them this is the dimension, and this is another dimension, instead of just doing charts.

From the reflections above, participant A6 was in a dilemma concerning the most effective methods to use for teaching students of different abilities. A5 also quickly caught up to the importance of using concrete artefacts to improve learners' understanding. Clearly, many of the pre-service teachers seemed to have a repertoire of strategies for teaching mathematics but still needed to learn the details of when and how to apply them during the actual teaching process. Their expectations about what would be needed did not seem to match up with the reality.

4.7.3 Expectations about classroom management

When pre-service teachers were asked to describe their expectations about teaching regarding their experiences, the common view was that classroom management was the one aspect they expected not to struggle with during teaching practice. This confirms the quantitative result which showed that 72% (n=105) of the pre-service teachers expected to be able to manage their classes (table 4.10, item 8). However, their experiences exposed that they still had plenty to learn in relation to classroom management. The following are remarks from students who had strong views about classroom management before teaching practice.

A6:   Before I went out on TP, I had this strong belief that if you get into class and say keep quiet to the students, they would just keep quiet, but that was not it. During the first week, they did not have the time to keep quiet if they were doing nothing in the classroom. At times they would even make fun of us and laugh out loudly. It's so frustrating especially when you think you are a

154

teacher. They actually know that this is a student teacher and this is a qualified teacher. They don't even respect you because they know us as students.

R5:   Managing large classes and teaching pupils who have negative attitude towards maths is challenging. Preparation for the lessons is time consuming. In the classroom you try to help this pupil because they have different abilities, the other ones are making noise. You don't finish what you had planned to teach because of this. Before TP, I thought managing large classes is not challenging. After my first day on TP, I had new thoughts about TP. It's really challenging in the sense that it becomes difficult to attend to individual problems in the class.

The pre-service teachers' estimation of their skills on classroom management before teaching practice seems to have been way off. According to Peters (2012), many pre-service teachers are concerned about classroom management, especially behaviour management, as one of the most challenging aspects of teaching. The findings in this study seem to suggest that prior to teaching practice the students thought otherwise, with many of the pre-service teachers assuming that their skills would be sufficient for the task. Evidently, teaching practice was the necessary wake up call for many of them. The pre-service teachers' experiences confirm the research findings by Gan (2013) and Muir *et al. (*2013) that classroom management is one of the challenges faced by pre-service teachers. The response below by student teacher A4 supports this assertion.

A4:   I also have a class that is considered the last but the noisiest. Right now they are behind, very much behind because, instead of me concentrating with finishing the topic, I am now concentrating with first making them quiet. Even when I teach, they ask you a thousand questions, "madam we didn't understand" you continue repeating but at the end of the day there is nothing that I have taught.

From the pre-service teachers' responses, the challenge of discipline in the classroom seemed to distract the teachers' focus from teaching. Gan (2013) surmises that problems of discipline may cause pre-service teachers to invest much time in classroom order instead of concentrating on pedagogical issues of teaching. As a result, failure of pre-service teachers to manage their class's behaviour may contribute to the low achievement of students (Oliver, 2007).

155

P2:   For me, it's a very difficult issue because kids, they are very difficult to talk to. For the first two weeks they were so resistant, but now they are getting better because I tell them, no, this is for you, I try to motivate them. Sometimes I remember I gave them a test, and I said the highest here I give you a prize. It was the second test. They had failed the first test, the second test the highest was about 16/20. Given the overall, I think it's about motivation.

Pre-service teacher P2 raised the point of the use of persuasion and extrinsic rewards to control his classes. A popular theme in literature asserts that extrinsic rewards diminish intrinsic motivation (Ledford, Gerhart & Fang, 2013).

4.7.4 Expectations about experiences with supervisors and learners

4.7.4.1 Practicum experiences with mentors and learners

Contrary to the quantitative results, pre-service teachers who took part in the FGI expected to be assigned to mentors who would be welcoming, helpful and ready to guide their mentees at all times. Their responses in questionnaire 1 indicated that they were unsure about the mentors they would meet during TP in terms of the mathematics content (24.3%), desire to work (18.3%) and their relationship with the pre-service teachers (43.7%), items 22, 23 and 24 respectively. In the FGI, they expected to experience few classes to teach and receive guidance from mentors who would sit by their side in the classroom. However, some explained that they expected to be in the classroom on their own without the mentors. The following reflections illustrate the common expectations from the participants.

A2:   I was thinking that when I go on teaching practice, I would have a mentor, and I don't own any class, it's the mentor's class. I expected the mentor to tell me that I am going to teach this and this. Now I am the owner and the teacher of those classes, throughout the year. So I am just a student at my college but here I am a teacher.

A5:   We thought you just get into class, teach and no mentor after you time and again. To be supervised every now and then, eish, it's boring and scary. You don't teach the way you teach every day when you are being supervised. Because you are scared, you end up leaving some of the things you are supposed to teach. One big surprise for me was about the paper work. This is just too much… My college did not prepare me for this…

A number of interesting points emerged from these remarks. In addition to the contradictory views that pre-service teachers had about mentorship, the picture that the students on TP expected differed from what they found on the ground. Based on these inconsistencies, the pre-service teachers' experiences of mentorship in schools varied with some receiving close supervision during their teaching practice while others did not. In addition to having problems of being supervised regularly by mentors, participant A5, for example, was also concerned about the amount of paper work she had to do during teaching practice. Gan (2013) stated that pre-service teachers are often shocked by the workload they have during teaching practice. This is not made easy, however, by the lack of supervision and/or effective mentoring during this time. Kelly and Tannehill (2012) have criticised mentors who lack professionalism and expertise to supervise or guide teachers on teaching practices.

4.8 Theme 2: Pre-service teachers' mathematics knowledge

4.8.1 Views about pre-service teachers' mathematics knowledge

4.8.1.1 Views about the mathematics pre-service teachers teach in schools

Quantitative data indicate that 75% of the mentors agreed that the pre-service teachers seem to know their mathematics content. In response to a question regarding the pre-service teachers' mathematics knowledge (question 10 of mentors' interviews), some of the mentors' responses explained why and how some mentors were not convinced by their mentees with respect to content mastery. Firstly, the classes allocated to pre-service teachers during TP may be indicative of this lack of confidence. There was consensus among mentors that they assigned pre-service teachers to teach forms 1 and 2 and none of the mentees was trusted with "O" level classes. The mentors, however, offered different reasons for the allocations. Some attributed this to the fact that pre-service teachers had a lot of work to do (planning and organising) and hence, could not afford to take examination classes. Others affirmed that pre-service teachers were not ready or well prepared to teach examination classes because pre-service teachers were viewed as teachers who lacked content. One mentor had the following to say,

M2: From what we have had so far, they have enough content of the subject at the levels that they have been given, because normally we get student teachers from college "a". When they come here, we give them forms 1 and 2.

No, we don't give them form 4s, usually when they come for teaching practice, we are saying they are not yet fully prepared and I, because I have got my form 4 class ... you are not satisfied as to, I mean delivery of the content, you need to do it yourself because we have got a syllabus that we have to cover with the form 4s.

In summary, M2 appears to suggest that pre-service teachers do not have the requisite knowledge to teach the senior classes. In spite of these misgivings, the quantitative data suggests that the majority of the mentors (75%) were satisfied that the pre-service teachers could teach mathematics up to "O" level. The sentiments by the mentors support what Kiggundu and Nayimuli (2009) found in their study that some mentors did not trust their mentees, especially during the time of writing public examinations. As a result of this, mentors seem unwilling to relinquish their examination classes to pre-service teachers, depriving them of the opportunity to practise with senior classes up to "O" level. Another mentor, M3 had this to say:

M3: Some of them do but some do not have content knowledge. Form fours, it's like when they come they always say, from the college we were told we have to teach forms 1 and 2 not forms 4s and 3s. That's what they normally say and if we are to give them those form 4s and form 3s, it will be after a desperate situation, maybe when we are understaffed or we really need a teacher to teach those but otherwise they don't really want to teach those because they say from the college we have to teach forms ones and twos.

The lack of confidence to teach the senior classes seems to go both ways, as M3's explanation suggests that some of the pre-service teachers were themselves unwilling to teach higher levels. This could be evidence of a lack of confidence about their content knowledge, especially given the fact that in the interviews with the college lecturers the idea of specifically allocating pre-service teachers to forms 1 and 2 only was refuted.

On the other hand, some mentors seem to attribute the pre-service teachers' lack of content knowledge to the way they are trained in college. They take the view that what they are taught in college is perhaps divorced from what they are expected to

teach in schools, which leaves the pre-service teachers with no confidence to teach "O" level work. M6 expressed his feelings about this issue as follows:

M6:   Pre-service teachers face problems balancing lesson plans, marking the work, aah, most of them struggle with content, to the extent that they even go the next lesson without being prepared… I don't know what can be done with the issue of lesson planning, especially when it should be typed, they spend 90% of their time writing lesson plans. Most of them don't have time for content preparation… They have problems with their content. They have no confidence. What they are taught at college has no link with what they teach here, because they are doing "integration" there, they come here they want to teach "transformations". There shouldn't be over emphasis on file assessment. What I am saying is; the lecturers should check; is he able to articulate, to transfer what is in his mind to the students? Does he understand how students learn themselves? There is a lecturer who spent 20 minutes in the class but one hour with the file. We give him a room at around 11:00, he leaves around something to 1.00pm. If you look at the time allocated to file inspection, but time spent on the hands on thing, that's what we are saying. The emphasis is more on the file.

The one point that the mentor seems to emphasise in the above speech is the need for the college syllabus to connect directly with the mathematics the pre-service teachers are going to teach in schools. This seems to be a call for better articulation between the college curriculum and the school curriculum. In addition, the mentors' comments provide indications on the apparent discord between the college lecturers' expectations as opposed to the mentors regarding the evidence of the pre-service teachers' content mastery and/or delivery. While the lecturers expect to see proper and formal documentation in the form of a lesson plan file, the mentors expect classroom delivery to be the main point of assessment during teaching practice.

While some mentors were complaining about the lack of content knowledge among pre-service teachers, M14 commended them on their good subject knowledge. However, she did pick up on their difficulties in disseminating the knowledge to the learners. Here is how she put it,

M14:   Their subject knowledge is quite good. But the problem that they face is the implementation, how to explain to the pupils. You know, as a teacher with experience, that's how you learn.

M14 raises two interesting issues, first the point about teaching practice as the opportunity for the pre-service teachers to gain experience of teaching and secondly the issue of pre-service teachers' lack of pedagogical content knowledge. The general sentiment among the mentors seems to be that the pre-service teachers struggled more with content delivery than with the content itself. The importance of PCK in "learning to teach" was emphasised by Shulman (1986) in his treatise of the need to amalgamate subject content and pedagogy during teaching. For other mentors, however, the fact that pre-service teachers are different may explain the different levels of mastery of content knowledge thus emphasising the need to closely observe and monitor each pre-service teacher during teaching practice.

4.8.1.2 Views about the mathematics that pre-service teachers learn in colleges

When asked to explain the kind of knowledge college lecturers wanted pre-service teachers to gain before teaching practice, 57% ($^4/_7$) of the participants indicated that there is a need for pre-service teachers to have knowledge of the mathematics they were going to teach in high school. Thus, the college syllabus had to include "O" level topics to give them confidence to teach at this level. However, it was also suggested that they needed advanced mathematics knowledge to enrich their content knowledge. The following responses provide examples of the lecturers' perspectives.

Lecturer 6:   I would want them to know the content they are going to teach thoroughly as well as the content that is above the work they are going to teach so that they would be able to explain the concepts correctly.

Lecturer 3:   Actually we would want them to have sound deep knowledge about the subject content that they are going to teach. They should know in depth or extensively the content they are going to be teaching in schools. They should know the syllabus, everything that is in the syllabus, they should be knowledgeable …

The above sentiments suggest that the college-based lecturers' main concern was, in particular, to equip pre-service teachers with knowledge of the mathematics content that they were going to teach in order to promote students' conceptual understanding of the subject. This agrees with the mentors' suggestion that there should be a link between colleges and school mathematics. In addition, the lecturers believed that the pre-service teachers also needed to learn advanced mathematics to be knowledgeable in the subject.

Van Es and Conroy (2009) argue that while teacher education programmes earnestly and persistently try to assist pre-service teachers to understand the core dimensions of mathematics teaching and learning, research (Ball *et al.*, 2005; Hill *et al.*, 2008; Tsao, 2005) shows that the majority of pre-service teachers are unable to teach mathematics for understanding. This is the ability to present the subject to the learners in a comprehensible way. Teaching mathematics for understanding also involves knowledge of and proficiency with mathematical concepts and procedures and the ability to reason and make sense of mathematics (Van Es & Conroy, 2009). The other 42.9% (n = 7) of the lecturers anticipated that the pre-service teachers would have knowledge of mathematics that is relevant to real life situations. The following remarks illustrate the lecturers' views on this issue.

Lecturer 5:   They must possess the knowledge that is workable, that is applicable. They must have the knowledge which is ready for immediate use. The mathematics that is tied to everyday living.

Lecturer 2:   I would want the students, not to depend mostly on the theoretical aspect of the subject but the practical aspect of it, the relevance of the subject life situations.

The study also highlighted that mathematics education was one of the mathematics courses learnt by pre-service teachers at their colleges. The American Mathematical Society (2012) defines mathematics education as an interdisciplinary enterprise that requires knowledge of teaching and learning and knowledge of mathematics. Although all the lecturers indicated that they appreciated mathematics education in the syllabus, they seemed to pay more attention to subject content and revealed that mathematics education had very little time on the timetable. For example, Lecturer 3

said,

> ...I also feel that mathematics education is not given enough time because even the students themselves, they think mathematics content: pure mathematics, statistics, and mechanics are more important than mathematics education. Even the timetable gives them that view… If it is time for mathematics education, people just say can I use your mathematics education time to do this and that. They do not hesitate to use that time for something else…

The college lecturers who participated in this study reported that mathematics education was normally allocated four hours per week, equivalent to two periods a week, whilst content courses (for example, statistics) take ten hours in college (a). In college (b), mathematics education was allocated 3 hours per week. Clearly, the evidence suggests that mathematics education does not get much attention at college level. As Wu (2014) explains, content knowledge alone is not enough to be a good teacher, thus pedagogy has a critical contribution to make to teacher knowledge. If they are deprived of this component, they become mathematics specialists rather than mathematics teachers, hence, members of the National Focus Group on Teaching of Mathematics (2006) contend that it is important to know how to *mathematise* than to know a lot of mathematics. Weimer (2008) also posits that to imagine mathematics content as more important than the process of learning it, is like considering a car as more important than the road. The content knowledge therefore, needs to be disseminated effectively to the learners and this skill is normally attained through mathematics education.

4.8.2 Course structure

4.8.2.1 Mathematics content taught /learnt in colleges and schools

Table 6A (appendix 6) compares the colleges' syllabi with the school syllabus to confirm the link between what pre-service teachers learn in college as preparation for teaching practice and what they teach during teaching practice. A summary of the syllabi for the two teachers' colleges, a school syllabus for "O" level ZIMSEC (4008/4028) and the textbooks used in schools are presented in the table. These syllabi cover the entire period of two years and not all topics are taught in the first year.

162

An analysis of the timetables and college syllabi against the school syllabus shows that indeed there are few "O" level topics covered by first year pre-service teachers before they go on teaching practice.

Lecturers expressed varied views regarding the curriculum used in the colleges. In response to the question that required them to confirm if the college syllabus was adequate to prepare pre-service teachers for TP, the interview conversations with some lecturers were as follows.

Lecturer 2:   The current syllabus is not exactly adequate, it needs to be revamped, the content part of it is rather too much, in relation to the time they spend in college.

While Lecturer 2 feels that the content is too much, Lecturer 4 thinks otherwise.

Lecturer 4:   I think so far, we have been trying but we realised we are making a mistake of leaving the core mathematics, which is mathematics up to "O" level. Normally our students have got areas of difficulty which they normally face when they go for teaching practice. They need to know this to enhance their confidence.

Lecturer 4 strongly feels that the inclusion of the 'O' level content in the college syllabus may enhance confidence in the pre-service teachers to present a lesson to the learners. Lecturers 7 and 5 have the view that ICT should be part of the college syllabus as reflected by the responses below.

Lecturer 7:   The way the mathematics syllabus is structured, I think it adequately prepared them. We also have the components of the new technique, like use of ICT. Yaa, but I am not satisfied not 100%, because they are not fully integrating the use of ICT but they usually use it for PowerPoint, the use of the mathematics and then from the YouTube.

Similarly, lecturer 5 said,

Lecturer 5:   It's not adequate, but the curriculum is good. More time should be given to peer education, mathematics education and videos taken for the students to see their weaknesses. Yes, something should be added to the syllabus, especially use of these incoming technologies (ICT), I think the support of the college, we can say, there must be something which can be done.

The diversity of views of the participants on the adequacy of mathematics content for pre-service teachers is evident from their observations above. Overall, there is a dominant view about the need to improve the college curriculum to include the use of ICTs in teaching mathematics and the addition of 'O' level content to the syllabus so that pre-service teachers develop high levels of confidence to teach mathematics in the classroom. It is conceivable that there are topics that the pre-service teachers may not have done well on themselves at "O" level and these require that they pay attention to them and improve on them before they stand in front of their classes as teachers. As Ball *et al.* (2005) explain, teachers need to be knowledgeable not only about mathematics that is taught to the students but more than what they will teach to the students so that they are able to answer unprecedented questions from the learners with confidence.

4.9 Theme 3: Experiences with mathematics teaching during teaching practice

4.9.1 Classroom practices

During teaching practice, pre-service teachers in this study faced multiple challenges including those associated with developing their teaching styles, time management during lessons, classroom management (refer to 4.7.3), lessons preparation and workload.

4.9.1.1 Teaching approaches

Although they were expected to apply various teaching methods during lessons, most of the pre-service teachers predominantly used the demonstration method and group work. Exposition and discovery, and question and answer methods were only mentioned occasionally. This was revealed by how student teachers explained their approaches to the lessons (questions 10 to15 of the FGI for pre-service teachers). Below is an example of one of these observations on teaching approaches.

A2:   First you do the introduction. The introductions should not empty the whole lesson in an introduction. Maybe I use something tangible or linked to their everyday life. For example, you are teaching equations, if you want to solve an equation, if you subtract both sides, what you give to this one, you do the same to the other side or give an example of a child living in a polygamous family. If I give this wife's child, I also give

the other wife's child. Once they have an idea of what is happening, you work out an example, you demonstrate the first example, one of the pupils then demonstrates the second example, then maybe pair work before individual work. We demonstrate pair work and discuss as a class, criticising where s/he went wrong, here and there, because of this and this, then after that we give individual work.

Pre-service teacher A2 takes the approach of teaching mathematics for understanding by using practical life examples in addition to the demonstration method. This may be in line with the approach advocated by Depaepe *et al.* (2013), who view knowledge for mathematics teaching as comprising knowledge of instructional strategies and representations as well as students' misconceptions to make information accessible to the learners.

Another pre-service teacher remarked as follows,

A3: As for me, I find demonstration, group work and individual work; they are working very much with the students. They usually understand demonstration within group work and pair work because they share ideas. I usually use group work, related to the media with work cards and at the same time I use group work only when it's a double period. It helps so much because students do not remain idle every day. They are always filled with something to do.

The above sentiment suggests that in addition to the "demonstration approach", the pre-service teacher uses group work in every double lesson to keep students occupied and focused on the work.

A4: For me I know they say you have to teach in English when teaching classes, but then, looking at the school that I am and the classes that I have, I cannot always use English, because most of my pupils especially form 2, the majority of them they are like 20 something units to 36 at grade 7. If I use English, they will tell you madam, "we have not understood anything". So I usually use English and Shona. I usually demonstrate. If they understand my demonstration, I also ask them to demonstrate.

For student A4, demonstration is vital but it also raises an important issue about the medium of instruction. The response by A4 illustrates this concern about the use of English as a second language to teach mathematical concepts; the student resorted to the use of the local language. This sometimes creates challenges during

assessment as discovered by Rakicioglu-Soylemez and Eroz-Tuga (2014) in their study of some pre-service teachers who used Turkish as a medium of instruction but then gave students work to do in English. While the intentions of the pre-service teachers were noble, this may sometimes not work in the best interest of the students. Similarly, A5 provides another example in terms of the variations of teaching styles and approaches even though he seems to prioritise group work as well.

A5:   Let's say I am teaching sets. First of all, I may give an introduction or define what a set is. After definition, I can give them examples, after that I give them group work whereby they identify things in sets. After that I can give them an exercise to write.

In addition to this, R1 and R3 mentioned activity–based teaching and question and answer methods respectively as some of the methods they used for teaching. The responses above show that pre-service teachers are aware of the student-centred approaches that attract the students' attention in a class, which Blumberg (2005) says promote student engagement with the content. The responses on teaching approaches confirm the quantitative data result in table 4.12 where the majority of the pre-service teachers (76%) had an understanding that their role was to transmit knowledge to the students for understanding.

4.9.1.2 Time management

Almost all the pre-service teachers cited challenges in time management as one of their key concerns during teaching practice. Nearly all of them indicated that during their early days of teaching it was difficult to predict learners' performance before a lesson so that they could determine the amount of work required per lesson. One of the pre-service teachers put it as follows.

R1:   I think I noted my weaknesses when I started teaching practice. The way I planned my lesson. I could not finish the work in a single period. I usually fail to teach within that time frame due to slow learners. I am given 30 minutes but I need more time so that they understand.

Contrary to the results of table 4.14, item 28, which indicates that 70% of the mentors appreciated pre-service teachers' time management skills, R1 explained that he had overestimated students' performance due to a lack of experience.

Francis (2008) contends that time does not change, no matter how organised one is. He therefore advises that the vital thing to do is to learn to work effectively and efficiently within the given time; otherwise, if teachers allow time to control them, they will never have enough.

4.9.1.3 Lesson preparation

Pre-service teachers were asked how they experienced the job of teaching. It was discovered that their major concerns were on lesson preparation that is preparing teaching media, lesson plans and schemes, evaluating and marking and supervision preparation, which they said was intimidating. Some explained that lesson delivery was actually better than lesson preparation. The following statements illustrate how they experienced lesson preparation.

Q: How did you experience the job of teaching? Is it difficult or easy? What do you consider the most challenging aspect of TP?

A3:   Yes, for me, it's the work load. The load is too much. You need to write those DLPs [daily lesson plans], you need to evaluate them. You need to mark every exercise. You need to give an exercise every day in mathematics. It's so challenging that you mark 200 books in a day.

P2:   I think the skill of ordering the content, because sometimes you discover you are now covering a topic, maybe sketching graphs then you discover that these pupils don't know something, what do I do, that's why I have to reteach. So I said let me just cancel this one, and do substitution first because the students could not draw the table of values. So sometimes you discover that. I think what you need to do is to be able to tell that these students did this, did this, they did this, to test them, pre-test or something before you start teaching a topic.

The sentiments by P2 add to improper planning, which could have been aggravated by a lack of experience. The 'teaching and re-teaching' may therefore be considered as part of "learning to teach". Similarly, T1 also has the challenge of teaching through trial and error in the use of media. Here is what he said,

T1:   Preparing media to capture the interest of the pupils has been challenging to me. I had problems choosing media to teach certain topics and media to teach certain groups of students. Sometimes you get into a class with a chart and then you see

that the students don't even need it. They can do without…

In addition to the opinions expressed above, R5 did not like the supervision part of teaching practice. As discussed earlier, perhaps the fact that much of the pre-service teachers' assessment by lecturers focuses on the lesson planning may create the anxieties about lesson planning as opposed to lesson delivery itself. The pre-service teachers' sentiments about lesson preparation echo the opinions of Martin (1998) and Zeichner and Liston (1987) that learning from field experiences is not without problems. The fact that these pre-service teachers are concerned about the workload, media preparation and the breakdown of concepts in lesson plans relates to the way the student teachers were prepared before teaching practice. This is confirmed by the chi-square test (table 4.11, item 7) which showed that the pre-service teachers' responses on how they were prepared for the classroom was influenced by the training institutions (p=0.001).

Furthermore, besides concurring that pre-service teachers enjoyed teaching practice, college supervisors also expressed some concerns over the difficulties that pre-service teachers experienced during teaching practice. Among other challenges, pre-service teachers had high teaching loads, which were against the policies of the colleges on the number of lessons to be taken by a pre-service teacher on teaching practice. The educators were concerned that teaching practice for the pre-service teachers was disrupted with commitments that did not form part of their roles as student teachers. For instance, some pre-service teachers were asked to teach other subjects such as science that they were not trained to teach in college and this burdened them unnecessarily. Lecturer 6 explained.

> These problems, they really vary, some might even emanate from college. If the students do not have adequate guidance, when they go out there, they will have problems. Some might come from the schools. We do have school's expectation that might be different from the expectation of the college. So I have also witnessed this that, we say our student teachers must not be given a high load, but when they go there they will be the only maths teachers around or will be added to one or 2 teachers around of a very big school. What do you expect? You will be given load. They say this one then you will be assessed on these 3 classes then these other 3, no, you are just teaching. And we have also noticed

that because they say maths teachers, you should be able to teach science, so they might also be given an extra load in science. This is really a problem. What else, because they are inexperienced, the way they might be treated, it may frustrate the student teacher, looked down upon. They might not be regarded as normal citizens calling them by names that might also be a source of problem. Let's consider also, even from their homes where they come from. At home there will be a lot of expectations, some of them do join tertiary education when they are married so the husbands, their wives would be expecting a lot, the in-laws will be expecting a lot, a lot of problems, really students do face a lot of challenges, a lot of them.

In summary, Lecturer 6 is of the view that the unnecessary workload that student teachers are allocated, in addition to their personal problems, contribute to problems of lesson preparation during teaching practice.

4.9.1.4 Pre-service teachers' disciplinary issues

Regardless of the challenges that they faced during teaching practice, pre-service teachers also had their own personal problems, according to their lecturers, which could affect their preparation and performance in the classroom. A reason for some pre-service teachers withdrawing, being expelled or failing teaching practice, was because of a lack of planning. This was aggravated by such behaviours as excessive drinking, absenteeism and laziness. Lecturer 4 thus lamented,

> There is one serious case of absenteeism. Absenteeism has actually made a lot of students fail. They are normally found out of the work place and some of the reasons at times, will be that a pre-service teacher is drunk and has taken to excess some alcohol, that is very serious. You find him having red eyes, each time you go there, red eyes. I know that actually creates a negative feeling on the part of the student. We also have problems of ladies who normally fall pregnant during teaching practice. Some will end up failing to come back especially when we have cases of miscarriage or something related to that. Such problems.

Such cases as explained above may stand in as the decider of failure or success in teaching mathematics during TP.

4.9.1.5 Pre-service teachers' practicum experiences with mentors and lecturers

The study exposed that pre-service teachers had challenges related to the quality of mentorship they received. This is in agreement with the results of table 4.16 of the quantitative data where most of the mean responses for mentorship assistance were below three. The pre-service teachers indicated that the mentoring was limited and for others, was completely absent.

A1:   We taught the very first day. I was even asked to teach on the first day without a lesson plan. I requested that she teaches first whilst I am watching but refused. She just thought the first form one topics are easy and I should be able to teach them easily even without preparation. You are told on the first day that do you know that you have a lesson?

Similarly, R3 had this view,

R3:   I am not getting enough assistance from the mentor and I'm being told to attend to HOD classes when they are having a meeting. I had to ask for help from other maths teachers in the department.

A2 was mainly concerned about the way she was being monitored. She had the view that the mentoring was doing more harm than good to her. She expressed her views as follows.

A2:   The fact that a mentor comes to assess me and then corrects me in front of the pupils, eish. The fact is, I don't have anyone to mentor me. If I had a mentor, s/he would teach me every day before I go for a lesson and I wouldn't make errors in front of the pupils. As you will be trying to work out a problem on the board for the pupils, the mentor raises her hand and corrects you then and there. It actually exposes me to the pupils.

During this stage of "learning to teach", Katz (1995) argues that the pre-service teacher needs support, encouragement, reassurance, comfort and guidance from the mentor, thus, the mentor should always be ready to provide the necessary assistance. Some of the pre-service teachers did not seem to experience that kind of support and mentoring. The importance of such continuous mentoring is evidenced by the following quote from A2.

A2:   Yes, but when lecturers came the first time and gave me 50%, I hated them.

However, through hard work, the mark continued to grow. If they had given me 90% I would relax. Even if I did not want to go for a lesson, no one would force me. I would just evaluate that I taught. But because, lecturers do come regularly, I am compelled to go for lessons.

It also emerged that regular supervision of pre-service teachers is crucial in the sense that it pushes pre-service teachers to work constantly during teaching practice. The pre-service teachers also expressed that the quality of the relationships that they had in the schools with their fellow teachers ultimately affected the way they taught in the classroom. Some pre-service teachers articulated this as follows.

A3: For me, the only problem I have is discrimination. I know I am a student, but then when it comes to motivation, when you motivate other permanent teachers don't say this we can't motivate because I am a student. I also need motivation, because I am working. If you don't motivate me, I know I am a student, I do it of course because it's my job, but I will not do it 100% (whole heartedly).

Similarly, another student had this to say,

A6: Sometimes we are like outcasts when we are treated. Say may be, the other members of staff were given mugs and they said it's not for student teachers, it's not for you. Sometimes it affects us, not because I want the mug or I can always buy it, but that discrimination. They print T-shirts for other teachers, they say they are not for students, the diaries, they are not for students. It demotivates us, even in the classroom.

Pre-service teachers felt that the other educators sometimes isolated them, looked down upon them and were acting unprofessionally towards them, which resulted in the pre-service teachers being constrained in their presence. The fact that pre-service teachers felt despised may instil fear and a lack of self-confidence in them. This is confirmed by Noel (2007) who asserts that pre-service teachers' bad experiences with other teachers in the school create uneasiness in their minds. Such bad experiences may also shape their classroom performance (Cakmak, 2008).

When asked to describe the assistance they received from college-based educators, most of the pre-service teachers indicated that they were supportive (table 4.17). However, some argued that the lecturers were rude to them. The views articulated

171

below are examples of how the pre-service teachers expressed their feelings concerning this issue.

R2:   The post mortem of the lesson with college lecturers helped me to identify my weaknesses. The constructive criticisms really gave me confidence in my future lessons.

R4:   Some college lecturers gave me negative comments about the lesson they had observed. I felt discouraged the first time they came. I felt hopeless because they never attempted to talk to me giving me a green light that things will be okay. It was like I have already failed TP. This killed my zeal for teaching.

R4's response is consistent with the report by Tan (2008) that if problems such as a lack of support from supervisors are not addressed, they are likely to affect pre-service teachers' performance in the classroom. Gulamhussein (2013) contends that pre-service teachers need even more support during implementation (teaching practice) in order to address the challenges of the classroom practices.

The study also established that colleges sometimes send supervisors who are not mathematics specialists to oversee pre-service teachers' work during TP, which seems to be unhelpful for the pre-service teachers in terms of content. M11 had this to say,

> The thing is, so far, what happens is, in the teachers' colleges, lecturers come from different departments and they have different requirements. The lecturer who comes to see the mathematics student is from a different department. So to tell the students what to expect exactly in terms of content, I don't think they themselves know.

Failure to give satisfactory feedback to pre-service teachers may conflict with the pre-service teachers' classroom practices.

4.10 Theme 4: Tools, resources and structures employed to facilitate "learning to teach mathematics"

4.10.1 Staff development strategies as tools to facilitate learning

4.10.1.1 Pre-service teachers' preparation for TP

After being asked to describe the kind of pre-service teachers enrolled at the

teachers' colleges, the lecturers expressed that the colleges enrol students with five "O" level passes including mathematics and English, as required by the Ministry of Higher Education. This would suggest that the students enrolled at teachers' colleges are knowledgeable about the mathematics they are expected to teach and should have the basic knowledge required to plan and provide instruction that promotes mathematical understanding.

Reponses from interviews with lecturers specified that the colleges provide some pedagogical support to pre-service teachers before teaching practice by having workshops on teaching practice, providing an opportunity for pre-service teachers to practise peer teaching and allowing them to use ICT equipment. However, some indicated that there were no teaching practice workshops held for pre-service teachers before teaching practice. The following statements illustrate the various views.

Lecturer 7:   In our subject, we usually equip them with the teaching methodologies on how to teach the subject, for example, use of the teaching methods like the discovery, the project method, the demonstration. I think after we have taught them those methodologies at the end of third term, usually they would go after three terms to TP, so at the end of third term, we usually have some peer teaching sessions, whereby we give the students about 30 minutes to deliver a lesson so that at least we see whether he is able to deliver a lesson. No TP workshops. The ones which are given the workshops are the lecturers.

From this remark, although the teachers' colleges are trying to equip the pre-service teachers with teaching skills before TP, it can be deduced that the time for practice (peer teaching) seems to be too short (30 minutes) to be assured of their ability to deliver a lesson, especially bearing in mind that there are no teaching practice workshops for them.

Lecturer 3:   To promote the improvement on how the schools deliver lessons, I think they have done something in our sections there, now we have an interactive board. I think it's a way of improving how to teach. We do workshops at college level, but not particularly for mathematics students.

Three issues are raised here. First, the use of ICTs to facilitate the teaching of mathematics and second workshops are conducted to develop teaching skills in the pre-service teachers. However, group workshops for all the pre-service teachers are conducted. The third issue, as articulated by Lecturer 6 below, is that mathematics has its own didactics, which differ from other subjects and therefore may need special attention, specifically with the mathematics pre-service teachers.

Lecturer 6:   We can say the college is doing not much because for pedagogy, besides maths section, we do have sections as professional development where they also consider how to teach, there is more of theory, theory, theory, there is little on the practice. Yes, we do carry out some sessions where they do practice, when they will be teaching their peers, but I think less time is being allocated and less resources are being channelled to that area. Yes, we do conduct pre-service workshops before they go and if we do realise even when they are out, we do carry out some.

Lecturer 6 is mainly complaining about limited resources and little time that is allocated to peer teaching.

Clearly, there were mixed views among lecturers about how pre-service teachers were prepared for teaching before teaching practice. This was a concern because the teacher education institutions play a pivotal role in preparing a highly qualified workforce (Rena, 2010). This shows that when pre-service teachers go on teaching practice, knowledge gained in college helps them to develop the knowledge and skills they need in the classroom. In preparation for teaching practice, pre-service teachers need the support of the college that is expected to equip them with the content and pedagogical skills to implement during teaching practice. The mixed views among lecturers show that although pre-service teachers are taught the pedagogy to use in schools, the resources may be limited. The pedagogy is more theory than practice and not every pre-service teacher is involved in peer teaching because of time. Hine (2015) proposes that teacher preparation through pedagogical support is significant for those who need or wish to improve students' learning. To this effect, Leke-ateh *et al.* (2013) recommend that pre-service teachers should be informed about the expectations of teaching practice prior to setting out on teaching practice.

After being asked if there was any assessment of the pre-service teachers before they leave for teaching practice, lecturers had the following to say:

Lecturer 5:   If the student has done dismally, has failed the content, he/she will not proceed to teaching practice… We consider course work, and also the peer teaching... but unfortunately, not all students may end up doing peer teaching, but they will just participate in those sessions. A few will teach, but we don't have time for each student.

Lecturer 6 concurs with Lecturer 5 as follows,

Lecturer 6:   Our assessment is based on just, mostly, content. We give them end of year examinations and if they pass that test, then they can go for their teaching practice. If they do not, we look at the areas that they are not doing well so that we adequately prepare them for their pre-service practice.

The views by Lecturer 7 are slightly different in the sense that in addition to content tests, peer teaching contributes to the final assessment before TP, probably because Lecturer 7 was from a different college. This highlighted the system that different colleges prepare their students differently. Lecturer 7 had this to say:

Lecturer 7:   As I have said that usually those are assignments and tests, you should pass. Usually we have said the components which basically constitute in our department, they are 2, (peer teaching and content tests) which contribute to the final assessment. So they are supposed to have passed those components before they go. If they fail, they will repeat.

The responses showed that some assessments were done before student teachers left for teaching practice. The majority of pre-service teachers, 82.9% (n=105), confirmed that the college did well to prepare them for TP (table 4.10). Wagner (2015) contends that pre-assessments show knowledge gaps that can be corrected, hence, defines pre-assessment as today's means of modifying tomorrow's instructions. However, the responses indicated that pre-service teachers' ability to proceed to teaching practice was determined by their knowledge of the mathematics content and not necessarily pedagogy and peer teaching. This is likely to result in pre-service teachers not taking peer teaching seriously, because whether they have done well or not, they still proceed for TP.

4.10.1.2 Mentors' preparation for TP supervision

It was essential in this study to establish how mentors are prepared for supervision because it is likely that the quality of work done by a mentor influences the quality of the pre-service teacher's performance during teaching practice. Ambrosetti (2014) contends that mentoring preparation, such as participating in mentoring courses, can help shape mentoring practices. Mentor preparation involved two aspects, assessment and training of mentors.

When asked if there were any specific requirements for a school-based teacher to qualify as a mentor, college lecturers appreciated the exercise of assessing mentors first before practice but observed that it did not happen at their colleges. Here is how the lecturers expressed the issue.

Lecturer 1: We expect someone who qualifies to be a mentor... but we leave that to the teaching practice department (laughs), we trust our headmasters in the schools. Workshops were carried out by the teaching practice offices with mentors and administrators together with lecturers.

Lecturer 4: Right, it's just good that we look at the mentors' qualifications and experience. If that person has no experience, definitely that person is not going to give enough help to our students....but really, we don't do it here at college "a". We have no assurance for the qualifications, that's the truth.

All the lecturers took the view that pre-service teachers are just deployed into the schools without assessing mentors' supervisory credentials. The verification of the type/qualifications of mentors seems to be the headmaster's prerogative.

Lecturer 3 noted that the quality of the mentor could only be assessed through the student teachers assigned to them. The student teachers were expected to report the mentor's faults. She affirmed it as follows:

Lecturer 3: …actually what we do, we sensitise the students. Our students are aware of the type of mentor he must work with, give them the standards so if the mentor is not performing up to those standards, they can report and then we don't know how it ends with the teaching practice office. But as a supervisor myself, I have never gone there and I have never tried to check on that. But if

the students are aware that this is not proper, that's how I get to know.

The general assumption of all the lecturers was that anyone with a teaching qualification was eligible to be a mentor and that because of a lack of evaluation of the mentors' qualifications, anyone could be mentoring the students without the college realising it. Peters (2012) advises that colleges should address this perceived lack of attention to the assessment of mentors' supervisory qualifications, which is a fundamental area of teacher education. Lecturer 7 noted,

> That's one of the challenges we have met, especially teachers who have degrees but without education, especially here in Bulawayo urban. There are graduates from (University X) without education, so, most pre-service teachers fall on those, and then at the end, they don't get enough help or assistance.

It emerged in the study that 10% (n=40) of the mentor participants had no teaching qualifications.

Concerning the training of mentors, Lecturer 6 said,

> For mentors those workshops have been carried out; in some, may be, say most regions, but I think the challenge might be when those workshops are carried out, usually it's not for every member in the section, so it could be one member per school or 2 members per school, which I still feel is not adequate because when our students go out on teaching practice they also have those other mentors who have not been trained because again to say, we want everyone to college, it's like we are now jeopardizing their system, they are not ready to release everyone for those workshops and it is also expensive on the part of the college. I don't know if it would be possible next time to arrange these workshops to be held during school holidays. People won't be available again and it will be extra work for the college.

The challenge is that failure to assess and train mentors may result in pre-service teachers being supervised by people of limited capabilities. From the focus group interviews conducted with school-based mentors, it emerged that some mentors lacked proper training and that there were no credentials required by the teachers' colleges. Some of them did not know what the colleges expected during mentoring. When asked if they needed anything to improve their mentorship, one of the mentors responded as follows:

M2:   … I should feel that colleges that are sending their students should come and talk to us as mentors so that they actually brief us on what they expect from their students. Sometimes you just get students, you don't know what the lecturers will be looking for, and you just say, well may be they need this, and then that is what you are going to provide but if they had come and then briefed us on what they expect, then we also focus on those. Lack of such information actually lessens our efficiency to supervise….

This suggests that the training of mentors may be somewhat limited. In the same vein, 82.1% of the mentors (n=39, table 4.18) claimed that they gained mentorship skills through experience. Ambrosetti (2014) echoes this contending that there are few teachers receiving training or mentoring preparation. Ambrosetti (2014) believes that mentoring is not an intrinsic skill therefore, mistakes are likely to be repeated in the absence of proper training. Without adequate assistance from the mentor, there may not be an improvement in mathematics teaching resulting from the mentoring.

4.10.1.3 College supervisors' preparation for teaching practice supervision

According to Anumaka (2016), with reference to Teacher Education in Sub-Saharan Africa (TESSA), the role of supervisors is to equip student teachers with skills and competencies to enable them to function effectively in the classroom. It is therefore, necessary for the college lecturers to be well acquainted with those skills of teaching practice supervision because the lecturer works closely with the student teacher on campus and in the field. The semi-structured interviews disclosed that colleges trained their lecturers for teaching practice supervision, although the training also seemed to be erratic. The following statements confirm this.

Lecturer 7:   For lecturers yes, we have workshops on how to conduct TP supervision. They are done at college level and not specifically for the mathematics department. They are done once a year, and I think this is not enough for some lecturers, especially the new lecturers to effectively supervise the students on TP.

Lecturer 3:   Yes, we do have workshops. We discuss the instruments that we use for teaching practice assessments (instruments 1 and 2).They also do orientation for lecturers. We normally meet to discuss these instruments as a college but

not regularly.

The fact that the workshops are sporadic is worrisome. Gulamhussein (2013) argues that any kind of professional development requires a significant amount of time and one-time workshops are not enough to change teaching/supervision practices.

4.10.2 Resources for teaching mathematics

4.10.2.1 Job resources – autonomy

When mentors were asked how often they sent pre-service teachers to teach their classes on their own, without the mentors' presence (item 7 of the mentors' interviews), the responses exhibited that pre-service teachers mostly "learnt to teach" mathematics with limited assistance. Mentors took the view that the students on teaching practice came to reduce their workloads. Therefore, in most cases, student teachers taught mentors' classes on their own. Some mentors' responses are given below.

M6:   I take the student teacher to class, introduce him to the class, give him the timetable, the textbooks, and then from there "bye bye" (whole group laughs) and whatever happens, it's between him and his lecturers and the pupils.

Unlike M6, M1 spent some time with the pre-service teacher. This is what he had to say.

M1:   Usually, we are saying first week, they are observing, and the second week, I am observing them teach. Then after that I am satisfied that he can actually teach and then leave him to teach on his own. I will be moving around to see whether there is order going on and here and there if there are problems, I intervene.

Similarly, M14 had this to say,

M14:   Normally, it should be like at least 2 weeks then she can go and have her own lessons. When she goes to have her own lessons now, the HOD is now the one who is more like responsible for checking her work because like the HOD is the superior. So when she thinks or he thinks I can handle this, then… [a hand sign to show goodbye].

This limited support, as reported by the mentor teachers, can defeat the whole

179

purpose of teaching practice. However, Rena (2010) suggests that while pre-service teachers may need exemplary models from their mentors, they need to be independent thinkers, learning and applying theories on their own, hence, equipped with autonomy.

4.10.2.2 Teaching resources

The responses from pre-service teachers conveyed that they did not have problems with teaching resources. Some pre-service teachers (PST) reported that the school leaders were supportive in terms of teaching resources, while others did not give responses about the resources when they were asked to explain the problems they had with teaching mathematics. The fact that pre-service teachers could talk extensively about other challenges and not so much about the issue of resources may suggest that resources were not such a major problem in their view. However, the quantitative data shows that 63.5% (n=104, table 4.10) of the pre-service teachers used the textbook quite often, which may suggest that it was the main resource they utilised as an instrument for teaching. This is not out of line with many studies that point to the importance of textbooks for mathematics teachers, especially according to Remillard (2009). The lecturers as opposed to the pre-service teachers brought up the issue of resources as a challenge. For example, here is how some of the lecturers expressed their concerns.

Lecturer 7: One of the challenges is mainly on… especially when they are supposed to make use of the teaching media, charts, models, but in some schools, they don't find those, so they end up buying them, sometimes because of their earnings that are meagre, they don't acquire those. Because some schools don't provide, they [students] provide for themselves.

Lecturer 1: Lack of resources, basically. Then, economic hardships in general they are affecting our students a lot. Some cannot afford to buy even clothing which enhances their confidence in front of the pupils.

It is unclear why the lecturers were concerned about the resources except for the fact that buying them may be a burden for the students in the end. However, the pre-service teachers did not share the sentiments. Perhaps the concern for the lecturers is to ensure that theory and practice are successfully integrated during teaching

practice and teaching resources may be critical to that process of integration (Harrison, 2003).

4.11 Theme 5: Differences between pre-service teachers' expectations and experiences of "learning to teach"

Under this theme, pre-service teachers' experiences are clarified in relation to their expectations about teaching practice, which were described under theme 1. Some of the differences between expectations and experiences, which came out of the quantitative data, may not be repeated in this section as they were discussed under section 4.5.5.

4.11.1 Pedagogical content knowledge gained by pre-service teachers on TP

When asked what they learnt during practice and what they thought they needed to improve on, most of the pre-service teachers pointed out that they had challenges in classroom management, teaching approaches, teaching media and lesson preparation.

(a) Classroom management

In the current study, findings suggest that there was a gap between what they were taught at college about classroom management and what they experienced in the classroom (see section 4.7.3). Similarly, Muir *et al.* (2013) contend that the area in which most of the pre-service teachers' dispositions remain intractable during "learning to teach" is the area of behaviour management. It is therefore incumbent on teachers' colleges to ensure that they equip pre-service teachers with knowledge and skills on behaviour management before teaching practice (Muir *et al.*, 2013).

(b) Teaching styles

In the study, it emerged that pre-service teachers over calibrated their ability to apply the teaching strategies learnt in college in their teaching during TP. With reference to sections 4.7.1.1 and 4.7.2.1, some of them were concerned about the strategies they should use when teaching learners of diverse abilities and when approaching different topics. This meant that the pre-service teachers had certain expectations of

teaching in the classroom without taking into consideration the type of students they were going to teach. Pre-service teachers disclosed that because some teaching methods were difficult to apply, contrary to their expectations, they ended up using one method of teaching for all the topics, especially the demonstration method. Furthermore, since some pre-service teachers were in a dilemma on which methods to teach and what topics they should teach, they ended up over scheming or over planning for a lesson (4.9.1.2). According to a study by Jusoh (2012), the most challenging factor among pre-service teachers was the difference between their expectations and the reality they faced. Darling-Hammond (2006) advises that pre-service teachers be exposed to effective professional development programmes before TP in order to improve their teaching practices during TP.

(c) Teaching tools

The views on teaching tools demonstrated that pre-service teachers were concerned about the preparation of teaching media and the integration of ICT into the teaching of mathematics, which was beyond their expectations. This was regardless of the fact that they had no problems with resource availability as discussed above (4.10.2.2). The teaching media are the vehicle through which students acquired means to connect with the new concepts they taught.

However, college educators expressed concerns over a lack of resources for use during lessons and recommended the use of ICTs to teach mathematics effectively during TP, which they said was lacking. The quantitative results on expectations of "learning to teach" (section 4.5.1) showed that pre-service teachers were confident in using all types of resources during TP, which they found difficult due to a lack of training and depleted resources in the schools.

(d) Lesson preparation

Although some pre-service teachers indicated that they learnt to plan for their lessons before TP (section 4.5.1), some of them had difficulties writing the objectives in a lesson plan, organising their lesson plans and breaking down a topic, starting with the pre-requisites as exposed in the interviews. Several pre-service teachers were complaining about their workload during TP, which was beyond their

expectations before TP (section 4.9.1.3).

4.11.2 Mentoring practices by college supervisors and mentor teachers

4.11.2.1 Supervision practices by mentor teachers

Responding to questions about the expectations and experiences on mentoring practices from their school-based mentors (items 19, 20 and 21 of pre-service teachers' interviews), pre-service teachers displayed dissatisfaction with the way they were being mentored. This implied that their expectations did not conform to what they were experiencing. Among the complaints was limited time with mentors, busy and/or lazy mentors, amongst others (section 4.9.1.5). However, some pre-service teachers, such as R1, were happy with the mentoring practices they received. The responses indicate that 81.8% (18/22) of the pre-service teachers mentored by teachers in positions of responsibility, for example, HODs, were affected by the lack of mentoring assistance (4.9.1.5).

4.11.2.2 Supervision practices by college supervisors

To what extent have the college supervisors assisted you to be successful in your teaching? Specify what they actually did for you (item 25, PST interview). Pre-service teachers commended college lecturers for supervising them effectively, which involved feedback, regular and thorough supervision. This was in line with the quantitative results where 50.5% of the pre-service teachers agreed that their college supervisors were supportive (table 4.17).

Regardless of the positive comments given by some pre-service teachers, R4 was concerned about the negative comments that he received from the supervisors, which he said "killed my zeal for teaching" (4.9.1.5). This confirms findings in the studies by Akhtar (2014) and Fong (2014) which showed that constant negative feedback can affect the students' confidence levels and may affect their personalities. Before TP, pre-service teachers expected supportive and encouraging supervisors.

4.11.3 Pre-service teachers' new beliefs, expectations and perceptions about teaching mathematics before and during teaching practice

When pre-service teachers on teaching practice were asked about their perspectives

on "teaching", as compared to their prior beliefs, expectations and perceptions (items 26, 27 and 28), over 72% (n=22) of the pre-service teachers involved in the interviews appreciated "teaching" as a good profession even though some of them were contemplating leaving the profession later in life. This confirms the results of table 4.20 in which the number of pre-service teachers appreciating "teaching" rose from 44.6% (n=119) before TP to 58.3% (n=103) during TP. However, pre-service teachers felt that the job of teaching was difficult but expected it to be easier after teaching practice. A2's response also showed that "teaching" was something that he never thought of before and that the feelings were developed from his teaching practice experiences. Yilmaz (2011), who asserts that teaching practice influences pre-service teachers' beliefs and perspectives about teaching as a profession, echoes the pre-service teachers' responses.

4.12 Theme 6: Suggestions and recommendations to improve TP

This section deals with suggestions and recommendations that were raised in the study by various participants. This was in relation to the experiences of participants as they associated with pre-service teachers during the process of "learning to teach".

4.12.1 Teaching practice supervision

Besides claiming to offer maximum support to students on teaching practice, mentors had mixed views about pre-service teachers' behaviour during teaching practice. Most of them stated that the behaviour of some pre-service teachers was unacceptable and that they were unable to build relationships with them. Responding to the questions on the problems that mentors faced with the pre-service teachers on TP, mentors reported that some of the pre-service teachers did not accept any advice from the mentors, some were weak in their teaching and some did not attend lessons. However, 21.4% (n=14) of the interviewed mentors agreed that they did not have any problems with the pre-service teachers on TP. The above claims were confirmed by the results of the interviews conducted with some of the mentors who had the following feelings towards their mentees.

M13: …there are some students who want to show you that they know. So much that when you want to assist them, they will tell you they know, but some are very cooperative.

Some are even difficult to mentor. You don't know the mark to give. Some do not attend lessons. You end up going to teach to cover up for your class.

The response from M13 suggests that the relationship between the mentors and their mentees was sour.

M2:   I personally have never faced problems with student teachers. Usually they are very compliant and participating. They are very cooperative.

The diversity of responses from M13 and M2 demonstrates that colleges train and develop pre-service teachers of diverse characters. Mentors and supervisors may therefore be expected to handle such pre-service teachers.

These results contradict the quantitative result, which indicated that mentors, in most cases appreciated the way pre-service teachers were performing in the classroom as reflected by the means above 3.67 for all the items in table 4.14. In addition, 87.5% (n=40) and 82.1% (n=40) agreed that they had a good relationship with the pre-service teachers and that mentees accepted advice, respectively. Only 7.7% (n=40) agreed that pre-service teachers were a burden to the schools. A number of key issues emerged from these data from the mentors. Pre-service teachers exhibited a number of unacceptable behaviours ranging from uncooperativeness to non-attendance of classes. Some pre-service teachers tried to demonstrate that they knew better than their mentors and would resist ideas to do certain duties. Although some mentors indicated that they did not have problems with the pre-service teachers, in circumstances where there was discord between the mentor and the mentee; it would become difficult to train a teacher who is unreceptive to instructions. Yet, according to Ambrosetti (2014), the relationship between the mentor and his/her mentee underpins the entire mentoring process, hence, he defines mentoring as a reciprocal relationship between the mentor and the mentee. This suggests that improvement in their relationship can cause the improvement in the pre-service teachers' performance in teaching mathematics.

Among the challenges of teaching practice, pre-service teachers suggested that there was a need for enhanced supervision by the mentors and college supervisors. They suggested improved communication in addition to timeous and regular

supervision. For example, P4 said,

> No, when the lecturers are coming, they must know that they just deployed us, not to get help from the mentors, but just to teach on our own. This means the lecturers have to visit us regularly in order to assist us.

Rosemary *et al*. (2013) report that the factors that affect teaching practice supervision, among others, are the supervision practices from college that are not regular, delayed supervision and little or no dialogue between the mentor and the mentees.

4.12.2 Staff development programmes for supervisors and pre-service teachers

When mentor teachers were asked to explain what they felt they needed to learn in order to improve their mentoring skills, they exposed mixed feelings about this issue. Some mentors mentioned that there is no connection between the college expectations and what the mentors do in practice, hence, they needed training for TP supervision. Some recommended that pre-service teachers needed practical experience prior to teaching practice so that it would also become easier for mentors to supervise them. The statements below confirm this.

M3: If I encounter a situation where the student teacher is difficult, someone with a personality which is difficult to handle, that's when I wish I was like, I was trained in that area how to handle this.

M14: Well, what I can only say is I think when these students come, they should be given more time, yes. With colleges they normally have this observation period before they go out on attachment. So that observation period, I think it's too short. You can't say somebody who just go out there and have lesson observation for 2 weeks or something like that has understood anything. I think what they should do with these colleges before these students are really sent out, wherever they want to go, a term would have been enough… So the two weeks is not like enough to gain enough experience to plan, to scheme, to record, to handle the class, to do all that…

In summary, M14 seems to be suggesting that pre-service teachers teach for a term during their time on campus before they embark on TP in schools.

4.12.3 Review of the mathematics taught in colleges

When the college educators were asked to describe the kind of knowledge that they would want their pre-service teachers to gain, as from previous discussions, they confirmed that the syllabus was adequate but recommended that it needs to include the following:

- (i)   the mathematics that pre-service teachers were going to teach in schools
- (ii)   the mathematics relevant to real life situations
- (iii)   the infusion of ICT into the teaching of mathematics
- (iv)   the mathematics that is above what they were going to teach to boost their confidence
- (v)   mathematics education

These views show that the colleges somewhat desire to equip the pre-service teachers with the PCK which, according to Shulman (1986), is the knowledge of content and teaching, content and curriculum and content and the students.

4.12.4 Working conditions

Some mentors in this study affirmed that they offered limited guidance to pre-service teachers. When they were asked to explain what they thought they needed to improve their mentorship skills, among several thoughts given was the fact that they were not being incentivised. Their motivation for mentoring was therefore lacking as one mentor teacher explained,

M9:   Teacher 9 actually thinks that colleges should honour up. They should actually show some recognition of the contribution being made by the mentor, in terms of remuneration if this exercise were going to continue to be fruitful because mentors actually do a lecture of training to the student teachers. Those teachers' colleges who are bringing in their students to a school should honour these mentors financially or in kind and that motivates the mentor (laughs).

These sentiments are in line with the "social exchange theory" of Leithwood (2006) which postulates that when employees are committed and dedicated, they need to be rewarded by the employer. This suggests that the quality of teaching, supervision and mentoring is likely to be influenced by the degree to which the supervisors and pre-service teachers' desires are satisfied.

187

4.13 Integration of quantitative and qualitative results

4.13.1 Expectations about "learning to teach"

The quantitative findings on pre-service teachers' expectations show that the majority of the pre-service teachers were positive about teaching practice before engagement in nearly all aspects of teaching that included teaching strategies, classroom management, motivational strategies, knowledge of learners and experiences with the supervisors. This is reflected by the global mean of 3.7939 in table 4.6. Eighty four point two per cent (84.2%) or (16/19) of the items had positive ideas about teaching practice prior to the school placement. The quantitative results are confirmed by the interview results, which showed that most pre-service teachers anticipated teaching practice to be without problems and to be a time of relief from the pressure of studies on campus. However, some of these expectations and beliefs were overestimated.

My findings are in line with those of Nicol and Crespo (2003) who established that pre-service teachers expect to become better teachers than the ones they know before teaching practice. However, Haser (2010) contends that pre-service teachers have expectations about teaching which normally exclude some basic knowledge of time limitations, student motivation and diversity among students.

4.13.2 What pre-service teachers learn about mathematics

The quantitative analysis showed that the pre-service teachers were conversant and confident about the mathematics they were teaching, as reflected by their responses on item 63 from questionnaire 2, in which they asserted that they did not find the mathematics they were teaching difficult. However, the results of the interviews seem to refute these results when the mentors revealed that they gave pre-service teachers lower level classes to teach because they lacked mathematics content knowledge. In addition, the interviews with college educators showed that although they focused plenty of time on subject content on campus, the pre-service teachers lacked the knowledge of the content that they were going to teach in high school. They therefore recommended the need for the college syllabi to include the core mathematics that would most likely give them the confidence in front of the learners.

The results from the questionnaires and the interviews suggest that although the pre-service teachers claimed that mathematics was not difficult, they could have been basing their judgements on the content they were teaching at lower levels. It is possible that if they were teaching "O" levels, the responses could be different. However, they maintained that they were willing and enthusiastic to teach "O" level content after qualifying (item 65, mean = 4.1). Furthermore, the timetables (appendix 6) showed that the mathematics education learnt in college is limited as shown by the number of hours per week allocated to this part of the syllabus.

4.13.3 Experiences about mathematics teaching during teaching practice

4.13.3.1 Classroom experiences

The paired samples test established that the pre-service teachers' experiences of "learning to teach" from teaching practice matched their expectations before teaching practice. In addition, this result is confirmed by the means of expectations before teaching practice (mean=3.90) and experiences during teaching practice (mean=3.99) in table 4.19. Some of the interview responses contradicted the responses given in questionnaire 2. As a result, the interviews with pre-service teachers revealed that in most cases, the pedagogy that pre-service teachers learnt in college during their first year was often dismissed as "unworkable" in the classroom. Nearly all the participants indicated that more than 60% of what they experienced during teaching practice was novel to them even though they expected teaching to be without difficulties.

4.13.4 Tools, resources and structures employed to facilitate "learning to teach" mathematics

The quantitative results illustrate that pre-service teachers were less positive about the assistance they received from their mentors as shown by the several mean item scores below 3 (table 4.16). This was confirmed by the interview results in which pre-service teachers reported that they did not receive assistance from the mentors while some of them were required to relieve the mentors of part of their workload. In addition, the questionnaires showed that a limited number of pre-service teachers accused some of their college lecturers and mentors of being rude, intimidating, too strict and sometimes lazy, although they mostly commended the lecturers for being

supportive (table 4.17). In this regard, the situation, which is meant to give pre-service teachers real classroom experience that is required for quality teaching may run counter to the definition of mentoring (Kleickman *et al.*, 2013).

With regard to supervisor preparation for TP supervision, the quantitative results (table 4.18) indicate that most of the mentors obtained their skills of supervision through experience. This implied that they might not have received any or enough training. The interview results with school- and college-based supervisors confirmed these results when the participants reported that the workshops on TP supervision were held rather erratically. In respect of job resources and teaching tools, the questionnaire data revealed that pre-service teachers did not have problems with the teaching resources. In addition, it was also discovered that the mentors allowed them to use the teaching methods they wanted to use during lessons (table 4.16, item 40). This constituted autonomy as an effective job resource. However, this result seemed to be obvious because pre-service teachers affirmed during interviews that they were on their own in the classroom most of the time. Therefore, it could be expected that they would use their own methods since there was little supervision.

4.13.5 Differences between pre-service teachers' expectations and experiences of "learning to teach"

From the questionnaires data, it appears that even though pre-service teachers' experiences and expectations about "learning to teach" matched, as disclosed by the paired sampled test (table 4.22), remarkable differences also emerged. It was noted that some pre-service teachers over-estimated their expectations before teaching practice. This was indicated by their views on the ability to apply college-learnt skills in teaching before teaching practice (figure 4.2). This was divorced from what they were going through as revealed by the interviews. This corresponds with the finding by Eisenhardt *et al.* (2012) that although some of these beliefs and expectations may be accurate, most of them are not applicable. However, it is important that pre-service teachers' beliefs, conceptions and expectations be considered in learning institutions in order to improve educational practices and prepare pre-service teachers for the actual teaching experiences (Yilmaz & Sahin, 2011).

4.14 Summary of the chapter

In this chapter, I presented, interpreted and analysed the collected data. Numeric information was summarised using tables, graphs and figures. Furthermore, open-ended questions have been grouped into related categories and were explained. Qualitative data from the interviews have also been comprehensively presented, interpreted and explained. However, the quantitative and qualitative results were presented separately and then integrated at the end.

The analysis of the interviews either confirmed or refuted the results of the data collected by the questionnaires. The findings of the quantitative and qualitative data in this study sometimes contradicted each other. However, the overall findings showed that teaching practice plays a pivotal role in the training of mathematics teachers. Students enter the teaching profession with expectations and beliefs about mathematics, which can be congruent or in conflict with their teaching experiences. These expectations may, however, be reshaped in order to improve the pre-service teachers' classroom performance and this can be done through their mentors and supervisors in the school system. Chapter 5 presents a detailed discussion of the findings, the conclusion, recommendations and provides a summary of the study.

CHAPTER 5

DISCUSSION OF FINDINGS, LINKAGES TO LITERATURE, SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

In this chapter, I discuss the emerging findings from the empirical data against the background of the insights from the literature reviewed in chapter 2. The purpose of the study was to investigate the significance and contribution of teaching practice (TP) to teacher knowledge, with reference to two Zimbabwean secondary teachers' colleges. After reviewing the key findings, this section presents a discussion of the findings of the study, draws conclusions and makes recommendations for further research, policy formulation and for the improvement of teacher education practice at the two colleges and beyond. The chapter begins with a summary of the entire thesis.

5.1 Summary of the study

This section of chapter 5 presents findings of the study on how pre-service teachers' field experiences contribute to teacher knowledge for mathematics, with special reference to two Zimbabwean secondary teachers' colleges. The purpose of the study was to explore the development of teacher knowledge for mathematics pre-service teachers in relation to the significance and contribution of field experiences (teaching practice) to teacher knowledge and expertise, as described by the concept of "learning to teach".

The study first established pre-service teachers' expectations and beliefs prior to teaching practice (TP) as baseline information to measure the impact of the intervention on pre-service teachers. This information was then compared with the same group of pre-service teachers' actual experiences and beliefs during teaching practice.

Based on the comparative data collected before and during teaching practice, the study focused on what pre-service teachers reportedly learnt about mathematics and the teaching of mathematics, how they learn about mathematics and mathematics teaching, their experiences during teaching practice, the difference between pre-

service teachers' prior expectations or beliefs and their experiences during teaching practice. Finally, the study draws conclusions and makes recommendations for the improvement of the teacher education programme for mathematics by pre-service teachers, especially concerning the teaching practice component.

Research paradigm and approach: Following a pragmatist philosophy to research, a mixed methods design was used to collect data from the pre-service teachers before and during teaching practice. Data were also collected from school-based mentors and college supervisors. Furthermore, some institutional documents were analysed to enhance the trustworthiness of the results from the questionnaires and interviews.

Data analysis: The analysis of quantitative data was done using the SPSS program in which Cronbach's alpha coefficient was calculated for each theme to test the reliability. Next, a factor analysis was conducted for the purpose of eradicating duplication from a set of correlated variables under various themes (Yong & Pearce, 2013). Thereafter, a satisfaction index was calculated to test whether the participants were satisfied or agreed with the various practices of teaching practice.

The chi-square test was used to show the association levels that existed between pre-service teachers' demographic data and their expectations and experiences. In general, the findings revealed that some responses were dependent on the age, school of internship and prior experience of pre-service teachers. The test was conducted at 95% level of significance, implying that there was an association between the various components if $p \leq 0.05$.

Descriptive data, such as percentages, means and standard deviation were also calculated to analyse the data collected through the questionnaires. I conducted a paired sample test to establish the significance of the difference between pre-service teachers' expectations before TP and their experiences during TP.

The qualitative data was systematically presented, interpreted, explained and integrated with the quantitative data in order to analyse and examine the way the mentors, college supervisors and pre-service teachers conceptualised the teaching of mathematics for understanding during teaching practice.

5.2   Discussion of findings

5.2.1 Expectations about learning to teach

The findings of the study under this section address the following research question:

> What are the expectations of "learning to teach" by pre-service teachers at two Zimbabwean colleges of education prior to going on teaching practice?

The quantitative and qualitative analyses in this study suggest that pre-service teachers have expectations about their mentorship practices, teaching practices and teaching mathematics before field placement which, in turn, influence their instructional practices in the classroom and their relationship with other educators during teaching practice. These expectations are normally determined by the ways in which pre-service teachers are trained in the various teacher training institutions and their previous experiences as untrained teachers (table 4.8). The empirical evidence in this study suggests that some pre-service teachers overestimated the students' learning needs and abilities to understand some mathematical concepts and their pedagogical competences to teach those concepts. The analysis reflected that pre-service teachers, contrary to their expectations, realised the need for more time and better skills to teach mathematics comprehensively as shown in section 4.9 of chapter 4.

My findings support the observations by Tarman (2012) that sometimes pre-service teachers discover that what they expect about teaching is divorced from their actual experiences during teaching practice. Consistent with the above results, researchers, such as Rena (2010), demonstrate how pre-service teachers' perceptions and expectations about teaching affect their teaching behaviour during teaching practice.

5.2.2 Pre-service teachers' mathematical knowledge during teaching practice

This section of chapter 5 presents findings that answer the following research question:

What do the pre-service teachers reportedl

y learn about mathematics during teaching practice?

The data analysis in the study suggests that the mathematics subject content that pre-service teachers learn in teachers' colleges is not directly linked to what they actually teach in the schools. Both school-based and college-based supervisors seem to agree with this assertion as evidenced in sections 4.8.1.1 and 4.8.2.1.

If pre-service teachers have little to offer to the learners in the classroom, a lack of confidence may begin to set in during teaching practice. This finding confirms the position of Russell-Bowie (2012) that one of the contributing factors to teaching anxiety is a lack of strong grounding in subject content knowledge. A fear of failure, ridicule from their supervisors or a fear of unpleasant consequences may also diminish pre-service teachers' confidence and acquisition of teaching skills. This is perhaps one reason why most of the pre-service teachers who participated in this study were denied permission to teach higher level classes (forms 3 and 4) during TP, as their school-based mentors did not believe that they had sufficient 'O' level mathematics content knowledge. One mentor expressed his views in section 4.8.1.1 of chapter 4 regarding this issue.

In line with the above observations, results from a study by Askew (2008) report that prospective teachers who exhibited weaknesses in teaching mathematics also exhibited a lack of confidence during their actual teaching. Similarly, Kessel (2009) found that a pre-service teacher has to possess the ability and skills to solve problems and present the solution to the students in a highly confident way if that teacher is to be viewed as effective at teaching mathematics. However, the data analysis shows that the provision of 'O' level mathematics content knowledge alone is not enough to develop the pre-service teachers mathematically as confirmed during the face-to-face interviews with college lecturers who commonly agreed and talked about 'enriching' the pre-service teachers' subject content knowledge. Ball *et al.* (2005) accept that pre-service teachers should be equipped with "specialised content knowledge", which is the content obtained without requiring any additional knowledge of the students or knowledge of teaching. My findings therefore support the understanding that the pre-service teachers need to know, not only the

mathematics they will teach school learners but also more than the level at which they will teach their students, so that they will be able to answer unexpected questions from their learners confidently.

5.2.3 Experiences of mathematics teaching during TP

The findings in this section are a summary of answers to the following research question:

> What do the pre-service teachers reportedly learn about mathematics teaching during teaching practice?

Although pre-service teachers had relatively adequate mathematics content knowledge for the levels that they were teaching (table 4.9), it is not only the content knowledge that develops them into effective teachers in the classroom. The content knowledge works well with proper guidance from the supervisors as far as classroom and pedagogical practices are concerned. Regardless of the mathematics content knowledge that pre-service teachers gained, the pre-service teachers demonstrated that they had challenges with their teaching styles/methodologies, planning and time management, to mention a few (see section 4.9.1.3 in chapter 4). If supervisors fail to offer proper mentorship and guidance to the pre-service teachers and do not develop the desired and effective teaching skills in them during TP, they will not be able to demonstrate the kind of teaching approaches that take cognisance of the interaction within and between social and cultural interests of learners for understanding (McDiarmid & Ball, 1988). However, Ball *et al.* (2005) believe that teachers with more content knowledge tend to apply effective methods of teaching (such as problem solving and inquiry) in the classroom. In contrast, Lowrie and Jorgensen (2015) maintain that pre-service teachers with high levels of mathematics content knowledge tend to use traditional ways of teaching. On the other hand, Holm and Kajander (2012) are of the opinion that those lacking content knowledge were willing to embrace current educational practices as compensation for a lack of success with teacher-focused instruction. In this study, however, there was no evidence that pre-service teachers with more content knowledge were better teachers in the classroom. It was also not conclusively proven that pre-service teachers with less content knowledge employed current methods of teaching to

enhance their learners' achievements.

The findings of the present study seem to suggest that the effectiveness of mathematics teaching does not only depend on the possession of subject content knowledge, as explained in table 4.15. The results of the quantitative survey data show that the ability to teach mathematics cannot be separated from the subject content knowledge (see table 4.15). Similarly, Ball *et al.* (2001) emphasise that teaching depends on subject content knowledge but subject content knowledge is not synonymous with teaching. This means that for pre-service teachers to be able to teach mathematics effectively, they need to demonstrate adequate mathematics content knowledge. However, having mathematics content knowledge alone does not imply the ability to teach that content. Hine (2015) agrees with Ball *et al.* (2001) on the interplay that exists between mathematics content and pedagogy when he argues that without mathematics content knowledge, the pedagogical processes may be impeded. However, Hine (2015) found that there is no consensus on what mathematics content knowledge is required to teach well. Based on the findings of this study, I argue that if teachers are conversant with the curriculum that they are going to teach and are acquainted with the skills to impart the knowledge to the learners effectively, then there is a better chance that they will teach well.

5.2.4 Tools, resources and structures employed to facilitate "learning to teach mathematics"

This section is a summary of elicited responses to the following research question:

> How do the pre-service teachers reportedly learn about mathematics and mathematics teaching during teaching practice, that is, what structures, resources and tools are employed during the "learning to teach" process?

The findings indicate that the preparation of pre-service teachers, assessment and training of mentors, training of college supervisors and the employment of support resources during teaching, all contribute to the means, tools and structures through which knowledge is shared with pre-service teachers to facilitate "learning to teach".

5.2.4.1 Pre-service teachers' preparation

Assessment: The analysis suggests that "learning to teach" becomes more effective with sufficient assessment of pre-service teachers before teaching practice. The qualitative data analysis determined that the assessment of pre-service teachers by teachers' colleges prior to teaching practice is based on mathematics subject content only and not pedagogy. Students who fail to satisfy the demands of "mechanics, statistics and pure mathematics" are not allowed to proceed with TP. This form of pre-assessment is, however, inadequate to establish competence, as discussed in section 4.10.1.1 of chapter 4. According to Mergler and Spooner-Lane (2012), pedagogical teaching practices enhance intellectual thinking and problem solving skills in pre-service teachers, which can assist them to teach effectively during teaching practice.

Workshops: The analysed data also indicate that preparation of pre-service teachers through well-organised workshops assists the development of teaching skills during "learning to teach". The study found that training institutions provide some pedagogical support to the mathematics pre-service teachers through workshops before they leave for TP. The workshops are conducted for all the student teachers leaving for TP and not specifically for the mathematics pre-service teachers only. Mathematics has its own didactics, which differs from other subjects and therefore mathematics pre-service teachers may benefit from special attention. Conducting group workshops may therefore be limited in terms of addressing the structure and logic of teaching mathematics, which examines the relations and organisational forms of teaching in accordance with the goals of the college and the school curriculum.

Supervision: The data also indicate that insufficient supervision by the school and college-based mentors has a negative effect on the development of pre-service teachers' skills to learn about mathematics and mathematics teaching. It emerged from the mentors' focus group interviews (FGI) that colleges sometimes sent supervisors who were not mathematics specialists to oversee pre-service teachers' work during TP. While this works in terms of workload management for college lecturers, it was inappropriate for the pre-service teachers in terms of content (section 4.9.1.5). This study therefore concurs with Evans *et al.* (2014) and Peake

(2006) who report that subject specialists are better positioned to perform supervision activities compared to non-specialists. They add that non-specialist supervisors may not be able to give appropriate feedback on the subject content of observed lessons. Evans *et al.* (2014) suggest that non-specialists lack expertise and confidence to assist mathematics pre-service teachers on the subject content since they are insufficiently equipped to offer advice.

5.2.4.2 School-based mentors' preparation

Mentor preparation involves two aspects, which are mentor training and mentor assessment. In this study, mentor training involved mentors participating in staff development programmes in order to gain and improve their mentoring skills. Mentor assessment involved a critical evaluation of the mentors' supervisory credentials before involving them in mentorship.

Training of mentors: The study found that mentor training makes a fundamental contribution to the learning of mathematics and mathematics teaching by pre-service teachers during TP. The data show that school-based mentors do not receive sufficient training to equip them with the necessary mentoring skills. As a result, mentors supervise pre-service teachers through trial and error, which may have a negative impact on the pre-service teachers' professional growth and efficiency to teach. This is illustrated in section 4.5.4.4 of the quantitative data analysis, which is compounded by what one mentor (M2) said.

> …Sometimes you just get students, you don't know what the lecturers will be looking for, and you just say, well maybe they need this, and then that is what you are going to provide but if they had come and then briefed us on what they expect, then we also focus on those. Lack of such information actually lessens our efficiency to supervise.

This is because the quality of work done by mentors also determines the quality of pre-service teachers' performances in the classroom under their supervision. Endeley (2014) asserts that the richness and value of teaching practice is dependent on the quality of the supervisor. This means that mentors' lack of training may result in the deficiency of teaching skills and development in pre-service teachers in the classroom. Hollins *et al.* (2014) also affirm that the assignment of mentorship roles to teachers without formal training downplays the significance of TP in teacher

education. This finding from the study adds value to understanding the efficiency of mentorship to the development of pre-service teachers. Training of mentors is thus critical for the improvement of pre-service teachers' skills of teaching during "learning to teach".

Assessment of mentors: With regard to the quantitative and qualitative analysis of data in this study, it was demonstrated that assessment of mentors' supervisory credentials is paramount to the learning of mathematics and mathematics teaching by pre-service teachers during "learning to teach". The study established that all mentors were appointed by their seniors to take on the role of mentorship, sometimes without considering their mentorship credentials. This deprived pre-service teachers of the assistance they were supposed to receive from qualified or experienced mentors as discussed in section 4.10.1.2 (chapter 4). The issue of assessing mentorship credentials among mentors has not been explored much in literature, especially in Zimbabwe. Hollins *et al.* (2014) and Kelly and Tannehill (2012) posit that mentors are normally appointed on a traditional standards basis where no other form of preparation is required except teaching experience. The findings of this study and the observations of Hollins *et al.* (2014) and Kelly and Tannehill (2012) seem to suggest that the way mentors are selected and engaged for their roles needs some scrutiny and improvement. A lack of assessment of mentors' supervisory credentials in this study may have led to some teachers without teaching qualifications supervising pre-service teachers on TP. The quantitative data (table 4.5) in this study shows that 10% (n = 40) of the mentors did not have teaching qualifications. The lack of assessment and training among teaching practice (TP) stakeholders is thus problematic for the provision of effective and quality support to enhance the professional growth of pre-service teachers (He *et al.,* 2006).

5.2.4.3   *College supervisors' preparation for TP supervision*

The study findings illustrate that regular workshops or training for college lecturers as preparation for TP supervision enhances the theoretical supervisory skills of lecturers which, hopefully, contributes to improving the process of "learning to teach" among pre-service teachers. The training or coaching on TP supervision for the lecturers is not adequate as discussed extensively in section 4.10.1.3 (chapter 4). According to Ajibade *et al.* (2010) a correlation between pedagogical training and

higher productivity in the universities exists. The fact that college lecturers in this study receive sporadic training on TP supervision (once a year) is cause for concern.

5.2.4.4 Support resources to facilitate the teaching of mathematics

The qualitative data suggest that using ICTs has changed the nature of teaching and learning mathematics as discussed in chapter 4 (see sections 4.12.3 and 4.11.1). However, the use of ICTs in the classroom by pre-service teachers in the study was found to be limited due to several reasons such as the following:

(i) A lack of resources in the schools, for example, software used in mathematics teaching and learning.

(ii) A lack of training or preparation of pre-service teachers to integrate ICTs into mathematics teaching.

(iii) A lack of training and resources among lecturers to integrate ICTs with mathematics teaching. This throws some doubt on how pre-service teachers could develop such a skill when their supervisors were themselves not sufficiently skilled.

The results of this study support the view by Jarret (1998), who argues that a teacher using ICTs in the classroom tends to be a leading team player rather than a sole dispenser of knowledge to the pupils. She avers that the use of ICTs increases learners' expectations of learning and the lessons tend to become student-centred in ways that raise desire among the learners to experiment and discover new knowledge. As one lecturer testifies, "So far, the use of ICT is minimal. Most schools do not have the gadgets…" The common practice in the classrooms was therefore the use of "chalk and talk" and manila sheets to demonstrate the concepts being taught.

5.2.5 Differences between pre-service teachers' expectations and experiences of "learning to teach"

This section sought responses to the research question:

What are the differences between the pre-service teachers' expectations and what they reportedly learn during teaching practice?

The quantitative and qualitative responses to the research question substantiated that, pre-service teachers' expectations before TP matched their experiences as shown by the means of 3.9 and 3.99 respectively (table 4.19). In addition, the difference between the pre-service teachers' expectations and their experiences during TP was insignificant as indicated by the paired sample test result (table 4.22), where the *p*-value was 0.193>0.05. This certifies that the pre-service teachers' expectations of "learning to teach" were closely related to their experiences during TP. However, the quantitative and qualitative results illustrated that there were disparities between pre-service teachers' expectations about "learning to teach" and their experiences in particular areas of teaching during TP. Similar to the study by Nahal (2009), there are certain areas where pre-service teachers' expectations do not conform to reality in the classrooms. In this study, the pre-service teachers' abilities to inculcate the skills learnt in college into their teaching, their experiences with school-based mentors and their perceptions and beliefs towards the teaching profession, marked the difference between pre-service teachers' expectations and experiences of "learning to teach" as explained below.

5.2.5.1 Application of teaching skills in the classroom by pre-service teachers

Although the quantitative data from table 4.19 and table 4.22 verify that pre-service teachers' expectations of "learning to teach" prior to teaching practice matched their classroom experiences during teaching practice, the mismatch between the two constructs (expectations and experiences) became evident after analysing individual items from questionnaire 1 and questionnaire 2 (items 16 and 18 respectively). The issue of "the ability to apply teaching skills learnt on campus in the classroom" emerged as a point of discrepancy between pre-service teachers' expectations and experiences of "learning to teach". This was shown by the decrease in response percentages from 89.8% (mean 4.28) to 61.1% (mean 3.62), (see figure 4.2). The interview results with the pre-service teachers also confirmed this (see section 4.11.1).

The disparities that exist indicate that pre-service teachers might have overestimated their ability to apply college-learnt skills in the classroom setting. This 'faulty perception' might have led to a lack of preparation because they thought everything was going to be easy. The overestimation, which could be accompanied by over-

202

confidence, can devastate the pre-service teachers' egos when they realise that their expectations are shattered. Consequently, it would affect the pre-service teachers' feelings of success. This result confirms findings by Sheafer (2014) that it is one thing to read about learning and teaching in a textbook but it is quite another to practise and see learning actually taking place in the classroom.

5.2.5.2 Mentoring experiences encountered by pre-service teachers

The subject of "mentoring practices" has become a consistent point of discrepancy between pre-service teachers' expectations and their experiences of "learning to teach" in this study. The results show that a negative relationship between pre-service teachers and their supervisors may have emerged from the high expectations that pre-service teachers in this study had of a warm relationship with and assistance from their mentors before teaching practice. According to Hudson (2016), a sound relationship between pre-service teachers and their supervisors assists pre-service teachers' psychological development. Furthermore, Nahal (2009) contends that if a bond is created between teachers and their students (pre-service teachers and their mentors in this study are no exception to this trend), communication is established and a relationship between them is developed. Once the relationship has been constructed, trust will be built and a sense of achievement is experienced to teach successfully in the classroom. On the other hand, if the relationship is diminished, pre-service teachers may hesitate to consult the mentors in the case of a problem, which may negatively affect their presentation in the classroom.

5.2.5.3 Beliefs about the teaching profession before and during TP

The empirical evidence in the study indicates that the pre-service teachers' perceptions with regard to selecting the teaching profession as their career marked the differences between their expectations and experiences of "learning to teach". The difference in participants accepting "teaching" as a profession that they expected, increased from 44.6% before teaching practice to 58.3% during teaching practice (table 4.20, items 21 and 29 before and during TP respectively). This indicates that teaching practice may have positively influenced pre-service teachers' perceptions towards "teaching" as a profession in this study. The National Council for

Accreditation of Teacher Education (NCATE) reported that well prepared teachers are likely to remain in teaching. According to the NCATE, teacher preparation involves subject matter preparation, pedagogical preparation and pre-service teacher education policies, amongst others. This implies that pre-service teachers in this study, regardless of the challenges they experienced during TP, were well groomed for teaching during teaching practice in terms of the content and pedagogy for teaching mathematics.

5.2.6 Contribution and significance of pre-service teachers' expectations and experiences to teacher knowledge

This section summarises the responses to the following research question:

> How can the pre-service teachers' experiences of "learning to teach" from teaching practice and their expectations be explained?

This section discusses the impact of pre-service teachers' experiences and expectations on their performance, during "learning to teach", based on the results presented and analysed in chapter 4. Generally, the quantitative and qualitative results of the study indicate that although pre-service teachers' expectations influence their experiences of "learning to teach", it is clear from the findings that their experiences of teaching are not always caused by those expectations. Many more things take place to direct the course of their experiences. This is evidenced in section 4.5.3.3 (chapter 4) which indicates that some of the pre-service teachers' practices are influenced by the kind of training they acquire from various institutions and the schools in which they will be practising and not necessarily their expectations. However, it is evident from the study findings that pre-service teachers have expectations before field placement about mathematics teaching and/or teaching practice (TP) which are normally overestimated. This affects the way they teach in the classroom (see section 4.9). This suggests that the pre-service teachers may enter classrooms with certain precast teaching methods in mind (a one-size-fits-all approach) only to change their teaching methods and beliefs after realising that their preconceived approaches were not easy to implement (section 4.7.2.1). Pre-service teachers may not have considered such factors as class sizes, cultural diversity, timetable congestion and students' aptitude and attitude towards

mathematics as key variables that could influence their teaching performances, lesson preparation or teaching styles during TP. According to Joram and Gabriele (1998), perceptions and expectations that pre-service teachers bring into the teaching profession have been shown to affect what and how they "learn to teach". Their expectations seemed not to match up with the reality.

Although the paired samples test (table 4.22) shows that there was a match between pre-service teachers' expectations before TP and experiences of "learning to teach", $p = 0.193 > 0.05$, there were disparities between pre-service teachers' abilities to apply their learnt skills in their teaching, mentoring practices and their perceptions about teaching as a profession. The fact that pre-service teachers' positive perceptions of "teaching" as a profession improved during TP (table 4.20) implies that field placement is a necessary and appropriate intervention on pre-service teachers' attitudes towards teaching. The differences on the application of skills and mentoring practices (figure 4.2) indicate that the theoretical knowledge that the pre-service teachers acquired in college might not have equipped them with the ability to act or implement it in the classroom. It could also be due to a lack of expert feedback from and limited time with supervisors, as it was reported in the interviews (section 4.11.2.1).

The findings on pre-service teachers' knowledge of mathematics and mathematics teaching illustrate that most of the mathematical concepts taught in the colleges seemed not to have a direct link with the mathematics taught in schools (section 4.8.1.1). This tends to create a vacuum between the TP practices and what they are taught on the college campus. As a result, pre-service teachers may have problems with mathematics content delivery during TP. This finding, which results in pre-service teachers being allocated lower level classes only, may have a negative impact on the performance of pre-service teachers and ultimately diminish their confidence in the classroom as they are clearly shown attitudes that indicate a lack of trust. If pre-service teachers practise teaching with lower level classes (forms 1 and 2), their mathematics teaching performance after training may be inadequate to cope with higher-level classes. This lack of confidence may even creep into their post-training professional lives, which in turn, may be attributed to the practices of "learning to teach".

In addition, the summary of the findings demonstrates that effective mathematics teaching during TP does not only depend on mathematics content but requires proper and adequate guidance from the supervisors in terms of mathematics content and pedagogy. This implies that failure of proper guidance from supervisors may lead some pre-service teachers to teach through trial and error. However, some pre-service teachers may revert to their prior experiences of teaching, which may not bestow the appropriate skills of teaching on them. An effective teacher in this study is therefore considered one who embraces knowledge of the subject and the ability to use appropriate teaching strategies to make information accessible to learners. The study hence concludes that mathematics content and mathematics teaching/pedagogy, in the process of "learning to teach", are intertwined. This implies that while mathematics content cannot be separated from the ability to teach it, mathematics content alone does not guarantee effectiveness to teach the subject. Failure by pre-service teachers and supervisors to realise this might result in one component being weak. If one component is lacking or weak, the pre-service teacher may not acquire the adequate skills and competences expected of them. This will affect the quality of the entire TP process.

A summary of the findings also indicates that pre-service teachers need to attend regular workshops, be properly assessed in terms of content and pedagogy and be supervised appropriately before TP in order for them to be equipped with the necessary skills for teaching practice. During workshops pre-service teachers delve into the full role of mathematics teachers because they have sufficient time to practise the application of skills in the classroom. Training and assessment of college and school-based mentors was found instrumental to the provision of professional growth among pre-service teachers. The general understanding was that the quality of mentors influences the quality of the pre-service teachers under their supervision. A lack of proper guidance of pre-service teachers could therefore emanate from a lack of mathematics teaching knowledge from the supervisors. This implies that it is necessary to train and assess mentors' supervisory credentials before they engage with mentorship because failure to do so may result in pre-service teachers being supervised by people of limited capabilities.

Several studies on teaching practice have included the training of mentors as one of

the tools that boost the quality of teaching practice supervision. The assessment and evaluation of the mentors' supervisory credentials before engagement seems to be neglected in most studies. This study has added to literature by inculcating the idea of assessing mentors' supervisory credentials before they are assigned to mentorships, which has not been explored much in Zimbabwe. This is because the study established that 10% of the mentors were graduate teachers without teaching qualifications. This was confirmed in the interviews with college lecturers. In addition, 2.5% of the mentors were new teachers, fresh from college. If assessments are not done and such mentors continue to supervise the pre-service teachers, this may negatively affect pre-service teachers' performances in teaching mathematics. In light of the above discussions and findings of the study, figure 5.1 below is a proposed model designed to improve the teaching of mathematics during field placement.
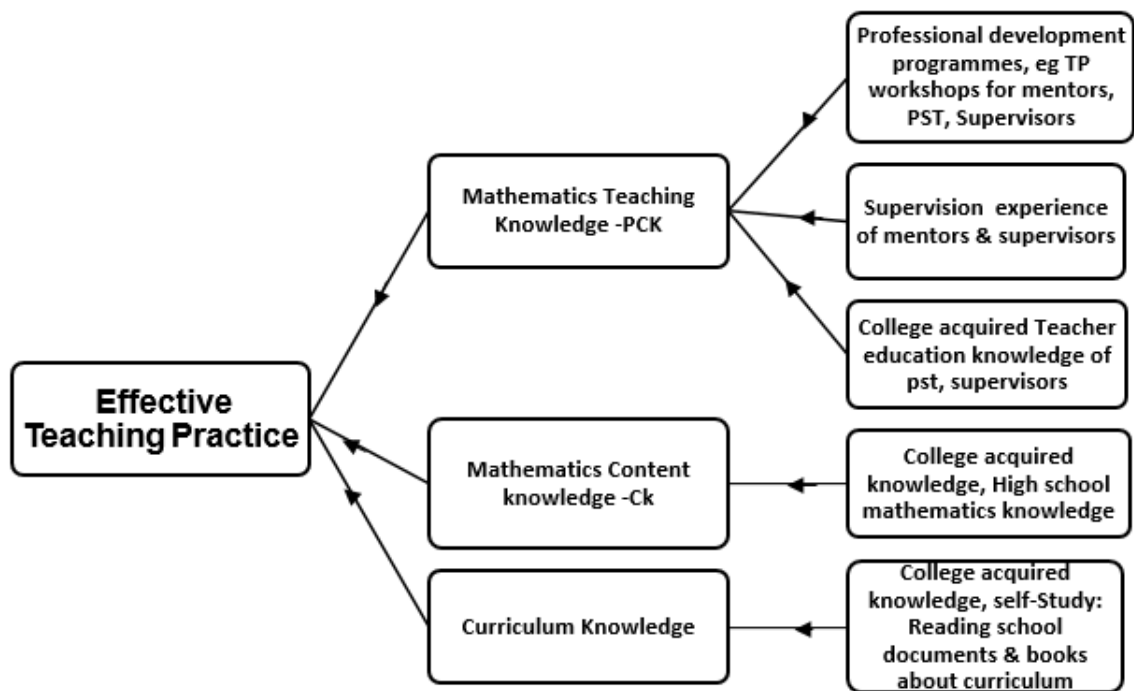
Figure 5.1: Proposed model for teaching practice composite

Figure 5.1 shows that the components from the right hand side of the model develop the content knowledge (CK), the pedagogical content knowledge (PCK) and curriculum knowledge of the pre-service teachers and these three constructs are the ones that build an effective TP programme. The study establishes that the PCK of

the pre-service teachers in the study is mainly developed from the college lectures and mentors' expertise in supervision (experiences as supervisors). Professional development programmes offered in colleges and universities that the pre-service teachers previously attended may further give rise to the development of their PCK (section 4.9). From the study, the pre-service teachers and college supervisors indicated that they gained their subject matter knowledge from high schools, universities and/or colleges (sections 4.8.1 and 4.8.2). This implies that most of the pre-service teachers' content knowledge (CK) is acquired from high schools and teachers' colleges. The fact that pre-service teachers raised the issue of erratic supervision from mentors (section 4.9.1.5), shows that their knowledge of the curriculum could have come from self-study, such as reading school documents concerning the curriculum in addition to college acquired knowledge.

These findings add to the current literature in that they re-establish a new position in the field of teaching practice and preparation of pre-service teachers in colleges. Therefore, there is a need for teacher educators to focus on adhering to the demands of teaching to improve pre-service teachers' classroom practices by adding value, not only to the mathematics content that pre-service teachers will teach but also to enhancing how they plan for the effective teaching of mathematics.

The study on "learning to teach" secondary school mathematics through practice in Zimbabwe is one of the unique studies that has been conducted in the country. Most studies are based on teaching practice only, without special reference to secondary school mathematics. Some of the studies tend to be restricted to the teaching and learning of mathematics in high schools in general excluding the concept of "learning to teach" through practice. In addition, the study has contributed to literature on teaching practice in Zimbabwe's teacher education by exploring the concept of "learning to teach" through practice from the point of view of the cohorts of pre-service teachers, mentors and college lecturers from several provinces. Some studies, for example by Maphosa *et al.* (2007) and Rosemary *et al.* (2013) focused on the mentorship of students on TP and was only based on the mentors and pre-service teachers' views. The inclusion of various participants in this study was done so that their suggestions, perceptions or conceptions about experiences of teaching mathematics could be consolidated since the participants need to work in

collaboration to have a successful teaching practice programme.

5.3 Implications and recommendations of the study

Based on the findings of the study, this section presents the possible implications and recommendations for practice, policy and further research as discussed below.

5.3.1 Recommendations for practice

Since the study focuses on Zimbabwean mathematics pre-service teachers before and during teaching practice, the findings of the study have implications on pre-service teachers' beliefs and expectations of "learning to teach" before teaching practice and how they influence their teaching practices during TP. The study reveals the need for teacher training institutions to investigate pre-service teachers' beliefs and expectations of teaching mathematics before TP in order to refocus their perceptions as an initial step to their professional preparation. For example, there is a need for teachers' colleges to focus on organising programmes on field experiences before student teachers leave for teaching practice so that they are acquainted and prepared to face teaching challenges, which may come as a shock.

In light of the findings and implications on pre-service teachers' mathematics content knowledge and mathematics teaching, the study recommends that the college syllabi be reviewed to include the core mathematics that pre-service teachers are going to teach at 'O' level. This needs to be executed so that there is direct link between the colleges' syllabi with the school syllabus. However, the provision of 'O' level content only to the pre-service teachers may not be enough to develop a mathematically effective teacher. In addition to the core mathematics, pre-service teachers therefore need to be enriched with the content above the level they are going to teach in order to enhance their confidence. Furthermore, effective mathematics teaching during practice (TP) needs to be approached in a holistic manner. This means that viewing only one component of teaching mathematics (among pedagogical content knowledge, content knowledge and curriculum knowledge) as the only contributing factor of TP effectiveness, may fail to achieve the goals of effective mathematics teaching during practice. If any one of these components is lacking or weak, pre-service teachers may not acquire adequate skills and competences expected of them and as a result, teaching practice may become ineffective. The study suggests

that effective teaching practice embraces all three components (PCK, CK and curriculum knowledge) as one body of knowledge. In view of this, the college syllabi can be revised to include a reasonable amount of mathematics education courses, in addition to the content, in order to instil mathematics pedagogical skills in the pre-service teachers.

Since the preparation of pre-service teachers before TP and the training and assessment of supervisors is pivotal to the effective teaching of mathematics in this study, colleges need to ensure that in every aspect of preparing the pre-service teachers, supervisors in the relevant areas of study are involved. In this instance, mathematics pre-service teachers on teaching practice may be supervised, mentored and workshopped by mathematics subject specialists who are well positioned in terms of mathematics content related feedback. In addition, effective mentoring can be executed by employing the following practices:

(i) teacher training colleges should conduct regular training and assessment of mentors' supervisory credentials before engagement to ensure that they are qualified for the job. That way, supervision skills are developed and only appropriate and well-qualified teacher mentors would supervise the pre-service teachers on TP;

(ii) teacher training colleges need to clearly specify and stipulate the attributes or standards they expect from school-based mentors in order to direct the quality and type of mentors who are assigned to supervise their pre-service teachers;

(iii) mentors need not be appointed but should volunteer their mentoring services because only then will they seek to fully understand the job they undertake effortlessly. Self-motivated mentors are likely to possess or develop attributes such as interest and desire to be involved and to continue learning about mentorship, since mentorship is central to pre-service teacher development.

The study findings show that the inculcation of ICTs into the teaching of mathematics promotes the use of learner-centred approaches in the classroom (section 4.8.2.1). This implies that the review of the teacher training colleges' syllabi needs to be done to include the infusion of ICTs into the teaching and learning of mathematics. Pre-service teachers, mentors and college lecturers need to be trained to be conversant with the use of ICTs to be able to facilitate the integration thereof into the teaching of

mathematics. Pre-service teachers also need to be deployed to schools where ICT provisions are available so that they can have hands-on practice.

Another implication for supervision practices in schools is the need to assign pre-service teachers to mentors based on their workload, to ensure that the pre-service teachers receive expert and prompt supervision during TP.

5.3.2 Implications for future research

The study findings, conclusions and recommendations are grounded in the responses given by the participants from the questionnaires and interviews in the study. The study can be extended to include the observation method of data collection, which was not employed in this study. In order to confirm pre-service teachers' practical experiences during TP, participant observation may provide a broader view, especially when researchers immerse themselves in the schools where the pre-service teachers would be practising.

Learners (high school pupils) were invisible in this study. They were not involved in questionnaire answering, neither were they involved in the interviews because of time limitations. A study by the American Mathematical Society (2012) found that the school system, communities, families, teachers and learners share responsibility for high quality learning. In addition, the learners are the ultimate beneficiaries of this study. Their voices need to be heard so that they may express their expectations about teachers on teaching practice. This implies that learners are crucial in the development of a teacher. Based on this, the study recommends that future research include the learners in schools to confirm pre-service teachers' experiences during TP.

5.3.3 Implications for policy

The providers of teacher education in Zimbabwe are the government, local authorities, church organisations and trustees. The heavy investment in education, especially by the government, is set to increase the *"vocationalisation"* of the curriculum and intensify the development of science, technology and mathematics at school level. However, without adequate funding for college lecturers and school-based mentor teachers, the production of quality teachers, who are required to teach

those subjects in schools effectively, may be compromised. The study found that remuneration is instrumental to the supervisors' efforts and performances in guiding pre-service teachers on TP. This has an implication that weak remuneration packages may cause low morale among teacher educators, which may ultimately negatively affect the performance of mathematics pre-service teachers. There is a need for the Government of Zimbabwe, especially relevant authorities in the Ministry of Education and the Ministry of Higher and Tertiary Education, to take stock of their effort and passion to motivate other stakeholders (college and school-based supervisors) so that teaching practice is enjoyable and successful. For example, teacher education authorities need to provide manpower development leave, bursaries and scholarships to mathematics mentors and mathematics lecturers so that they engage in the teacher developmental programmes, either on a full-time or on a part-time basis. This will enable them to be equipped with skills to monitor, guide and teach mathematics to the mathematics pre-service teachers who are "learning to teach". This is because the study established that the quality of the teacher educators influences the quality of the pre-service teachers. There is also a need for the provision of adequate and appropriate equipment by the responsible authorities for the effective teaching of mathematics in schools and teachers' colleges so that pre-service teachers have hands-on experience of the equipment.

5.4   Conclusion

The purpose of the study was to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach" for secondary school mathematics in Zimbabwe. The current study established that teaching practice is central to all teacher training programmes in Zimbabwe, as it is in other countries, as confirmed by Eisenhardt *et al.* (2012), Gan (2013), Hamaidi *et al.* (2014), Nestojko *et al.* (2014), and Santagata *et al.* (2007). In addition, it provides opportunities for pre-service teachers to spend time in real classrooms with the assistance of a mentor (Endeley, 2014). The study however established that it is not about the amount of time spent on teaching practice for a quality mathematics teacher to develop. In other words, the findings clearly spell out that unless pre-service teachers develop the ability to teach for understanding, develop pedagogical skills for teaching mathematics effectively, the ability to solve

mathematical problems in the classroom and the skill to relate and teach learners of diverse abilities during TP, then teaching practice ceases to satisfy the goals of "learning to teach". According to Endeley (2014), teaching practice is meant to develop skills and competences for effective teaching, application of principles studied to teach and to bring about change for practice in the pre-service teacher. The study thus established that if the pre-service teachers' beliefs and knowledge of mathematics remain intractable during TP then no learning would have taken place and the purpose of teaching practice is defeated. The study, hence, concludes that quality teaching of mathematics by pre-service teachers during teaching practice requires committed and dedicated supervisors with adequate subject matter knowledge and effective teaching skills to support the pre-service teacher during teaching practice. This can be possible if the government bears the financial burden for teacher education to ensure an adequate and well-trained teaching force (mentors and lecturers) in colleges and schools.

According to Schmidt and Maier (2009) and Kim *et al.* (2011), there is no agreement on the place and significance of field experiences in the development of teacher knowledge. This study contributes to this debate by presenting the findings on the significance of field experiences on teacher knowledge in Zimbabwe and the manner in which these experiences can account for the kind of mathematics knowledge that is crucial for success in secondary school mathematics. The findings of this study suggest that TP is a necessary and appropriate process that pre-service teachers need during "learning to teach". However, the effective teaching of mathematics during field placements requires pre-service teachers to embrace PCK, CK and curriculum knowledge as one body of knowledge that develops the skill of mathematics teaching in the pre-service teacher. Accordingly, the study makes important recommendations for practice, for further research and for policy to ensure that the teaching of secondary school mathematics is improved through practice.

5.5   Final remarks

The present study was primarily founded on two premises. First, that the improvement in the teaching and learning of secondary school mathematics in the classroom is related to practitioner development. Second, that field experiences are

important for the development of teaching. The study, therefore, presented an opportunity for me to investigate how the field experiences help to prepare pre-service teachers to teach mathematics in a way that begins to address the performance deficits in Zimbabwean secondary school mathematics. Data collected using questionnaires and interviews revealed the strengths and weaknesses of the pre-service training practice and thereby enabled me to offer some recommendations to address the situation.

One key insight I gained from the study is that the performance of a pre-service teacher is shaped by a number of factors such as the teacher training college programme, the context in the schools offering teaching practice or internship and the learners taught by the pre-service teacher in the schools. In other words, I now understand that the quality of a pre-service teacher is related to the content and quality of guidance provided by the schools offering internship and the teacher training colleges. While research has it that the expectations of teaching before TP influence the pre-service teachers' experiences during teaching practice (TP), a lot more happens during TP to shape the knowledge and experiences of the pre-service teachers. Further research on "learning to teach" mathematics from practice is needed to unpack the following questions, among others: the effects of supervision on the performance of pre-service teachers during TP, the impact of the pre-service teachers' expectations on their TP experiences, and how contexts influence pre-service teachers' learning about mathematics and mathematics teaching during TP.

REFERENCES

Acquah, B.Y.S. & Partey, P.A. 2014. The importance of field experience in teacher preparation: Perspectives of trainee economics teachers in the University of Cape Coast. *International Journal of Research in Social Sciences*, 4(4), 58-63.

Adler, J. 2005. Mathematics for teaching: What is it and why is it important that we talk about it? *Pythagoras*, 62, 1-11.

Agyei, D.D. & Voogt, J. 2010. ICT use in the teaching of mathematics: Implications for professional development of pre-service teachers in Ghana. *Education and Information Technologies*, 16(4), 423-439.

Ajibade, Y.A., Oloyede, E.O. & Adeleke, M.A. 2010. Lecturers' views on and attitudes to pedagogical skills training: Obafemi Awolowo University as a case study. *Review of Higher Education in Africa*, 2(1), 45-64.

Akhtar, M. 2014. Effects of teachers' comments and expectations on the learning experience of students. *International Journal of Physical and Social Sciences*, 4(3), 324-335.

Al-Ajez, F. & Hallas, D. 2011. The reality of practicum program at the faculty of education at the Islamic University in Gaza and its ways to improve it. *The Journal of the Islamic University*, 19(2), 1-46.

Aliaga, M. & Gunderson, B. 2003. *Interactive statistics.* Michigan: Prentice Hall/Pearson Education.

Allen, J.M. & Peach, D. 2007. Exploring connections between the in-field and on-campus components of a pre-service teacher education program: A student perspective. *Asia-Pacific Journal of Cooperative Education,* 8(1), 23-36.

Altintas, S. & Gorgen, I. 2014. The opinions of pre-service teachers about teaching practice. *International Periodical for the Languages, Literature and History of Turkish or Turkic.* 9(8), 197-208.

Ambrose, R. 2004. Initiating change in prospective elementary school teachers' orientations to mathematics teaching by building on beliefs. *Journal of mathematics Teacher Education*, 7(2), 91-119.

Ambrosetti, A. 2014. Are you ready to be a mentor? Preparing teachers for mentoring pre-service teachers. *Australian Journal of Teacher Education*, 39(6), 30-42.

American Mathematical Society. 2012. *The mathematical education of teachers II.*

Conference board of the mathematical sciences (CBMS). Issues in mathematics education. Washington DC: Library of congress cataloguing-in-publication.

An, S., Kulm, G. & Wu, Z. 2004. The pedagogical content knowledge of middle school, mathematics teachers in China and the U.S*. Journal of Mathematics Teacher Education* 7, 145-172.

Anumaka, I.B. 2016. Professionalising teaching in higher education in sub-sahara Africa (TESSA): Towards attainment of sustainable development goals. *American Journal of Educational Research and Reflection, 1, A1-A12.* Retrieved from: http://www.ASRAresearch.org/ajerr-vol-1-no-1-2016/.

Arain, M., Campbell, M.J., Cooper, C.L. & Lancaster, G.A. 2010. What is a pilot study or feasibility study? A review of current practice and editorial policy. *Medical Research Methodology*, 10(67), 1-7.

Arnold, E. 2006. Assessing the quality of mentoring: sinking or learning to swim*. ELT journal*, 60(2), 117-124.

Askew, M. 2008. Mathematical discipline knowledge requirements for prospective primary teachers and the structure and teaching approaches of programs designed to develop that knowledge*.* In Sullivan, P. & Terry, W. *Knowledge and beliefs in mathematics teaching and teacher development.* pp. 13-36. Rotterdam: Sense.

Avalos, B. 2011.Teacher professional development in teaching and teacher education over 10 years. *Teaching and Teacher Education*, 27, 10-20.

Bakker, A.B. & Bal, M.P. 2010. Weekly work engagement and performance: A study among starting teachers. *Journal of Occupational and Organisational Psychology*, 83(1), 189-206.

Bakker, A.S. & Demerouti, E. 2007. The job demands-resources model: State of the art. *Journal of Managerial Psychology*, 22(3), 309-328.

Ball, D.L., Hill, H.C. & Bass, H. 2005. Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *Journal of the American Federation of Teachers,* 14-47.

Ball, D.L., Lubienski, S. & Mewborn, D. 2001. Research on teaching Mathematics: The unsolved problem of teachers' Mathematical knowledge*.* In Richardson, V. (Ed), *Handbook of research on teaching.* 4th ed., pp.433-456. Washington, DC: American Educational Research Association.

Ball, D.L., Thames, M.H. & Phelps, G. 2008. Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389-407.

Bandura, A. 1997. *Self-efficacy: The exercise of control*. New York, NY: W.H, Freeman/Times books/Henry Holt & Company, pp. 604.

Barahona, M. 2014. Pre-service teachers' beliefs in the activity of learning to teach English in the Chilean context. *Cultural Historical Psychology*, 10(2), 116-122 Australia: The Australian National University.

Barnard, R. & Torres-Guzman, M.E. 2008. *Creating classroom communities of learning: International case studies and perspectives.* Bristol, UK: Multilingualism Matters.

Barry, N.H. & Lechner, J.V. 1995. Pre-service teachers' attitudes about and awareness of multicultural teaching and learning. *Teaching and Teacher education*, 11, 149-161.

Bekdemir, M. 2010. The pre-service teachers' mathematics anxiety related to depth of negative experiences in mathematics classroom while they were students*. Educational Studies in mathematics,* 75, 311-328.

Bennett, S.N. & Turner-Bisset. 1993. Case studies in learning to teach. In N. Bennett & C. Carre (Eds.). *Learning to teach*. London/New York: Routledge. pp. 165-190.

Billington, E. & DiTommaso, N.M. 2003. Demonstration and applications of the matching law in education. *Journal of Behavioural Education*, 12(2), 91-104.

Blumberg, P. 2005. *Implementing learning centred approaches in your teaching*. Philadelphia: University of the Sciences.

Borko, H., Peressini, D., Romagnano, L., Knuth, E., Willis-Yorker, C., Wooley, C. & Masarik, K. 2000. Teacher education does matter: A situative view of learning to teach secondary mathematics. *Educational Psychologist*, 35(3), 193-206.

Bowen, G.A. 2009. Document analysis as a qualitative research method. *Qualitative Research Journal*, 9(2), 27-40.

Bowora, W. 2008. *Ethics in private schools.* Harare: College Press.

Brenner, M.E. 2006. Interviewing in education research. *A Handbook of complementary Methods in Education*. Pp. 357-370. Santa Barbara: University of California.

Bricki, N. 2007. *A guide to using qualitative research methodology*. London:

Medecins Sans Frontieres.

Briley, J.S. 2012. The relationships among mathematics teaching efficacy, mathematics self-efficacy and mathematics beliefs for elementary pre-service teachers. *Issues in the Undergraduate Mathematics Preparation of School Teachers, The Journal,* 5, 1-13.

British Educational Research Association (BERA). 2011. *Ethical guidelines for educational research association.* London: Sage Publications.

Brock, B. & Grady, M.L. 1998. Beginning teacher induction programs. *Paper presented at the annual meeting of the National Council of Professors in Educational Administration*, Corpus Christi, TX.

Bryman, A. 2006. Integrating quantitative and qualitative research: how is it done? *Qualitative Research*, 6(1), 97-113.

Burns, N. & Grove, S. 2007. *Understanding nursing research: Building an evidence-based practice.* St Louise: Elsevier.

Cakmak, M. 2008. Concerns about teaching process: Student teachers' perspective. *Educational Research Quarterly*, 31(3), 57-77.

Cameron, R. 2011. Mixed methods research: The five Ps framework. *The Electronic Journal of Business Research Methods*, 9(2), 96-108: Academic publishing International.

Carpenter, T.P., Fennema, E. & Franke, M.L. 1996. Cognitively guided instruction: A knowledge base for reform in primary mathematics instruction. *The Elementary School Journal*, 97(1).

Carson, D., Gilmore, A., Perry, C. & Gronhaug, K. 2001. *Qualitative market research.* London: Sage Publications.

Carter, K. 1990. Teachers' knowledge and learning to teach. In Houston, R.W. (Ed.). *Handbook of research on teacher education* (pp. 292-310). New York: Macmillan.

Cavanagh, M. & Prescott, A. 2007. Professional experience in learning to teach secondary mathematics: Incorporating pre-service teachers into a community of practice. In J. Watson & K. Beswick (Eds.)*, Mathematics: Essential research, essential practice.* Proceedings of the 30th annual conference of the Mathematics Education Research Group of Australasia, 1, pp. 273-280.

Chalies, S., Escalie, G., Bertone, S. & Clarke, A. 2012. Learning "rules" of practice within the context of the practicum triad: A case study of learning to teach.

Canadian Journal of Education, 35(2), 3-23.

Chan, K.W. & Elliot, R.G. 2004. Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education*, 20(8), 817-831.

Chikutuma, T. 2014. *The quality of early childhood development programmes in Harare primary schools in Zimbabwe*. PhD thesis. Pretoria: Unisa.

Childers-Hon, L. 2008. *Guidelines for writing a thesis or dissertation*. Available at www.jou.ufl.edu/.../Guidelines-for-writing-thesis-or-dissertation.pdf [Accessed 16 June 2016].

Chu, F.T. 1993. *Interviewing in educational research: A bibliographic essay*. Macomb, IL: Western Illinois University.

Clinician, B.O. & Clinician, B.C.W. 2009. *Fuller and Brown's stages of concern: a model for beginning teacher growth.* University of Miami Music Education Forum.

Clough, P. & Nutbrown, C. 2007. *A student's guide to methodology: Justifying inquiry.* London: Sage Publications.

Cochran, K.F., DeRuiter, J.A. & King, R. 1991. *Pedagogical content knowledge: A tentative model for teacher preparation.* Paper presented at the annual meeting of the American educational research association, Chicago.

Cohen, L., Manion, L. & Morrison, K. 2007. *Research methods in education*. New York: Routledge.

Cohen, L., Manion, R. & Morrison, K. 2013. *Research methods in education,* 7th edition. Hoboken: Taylor & Francis.

Cole, A.L. & Knowles, J.G. 1993. Shattered images: Understanding expectations and realities of field experiences. *Teaching and Teacher Education*, 9(5-6), 457-471.

Conway, P.F. 2002. Learning in communities of practice: Rethinking teaching and learning in disadvantaged contexts. *Irish Educational Studies*, 21(3), 61-91.

Cooper, P. & McIntyre, D. 1998. *Effective teaching and learning. Teachers and students' perspectives.* UK: Open University Press.

Crabtree, B. & Cohen, D. 2008. *Qualitative research guidelines project.* New Jersey: The Robert Wood Johnson Foundations.

Cranton, P. 2006. *Understanding and promoting transformative learning: A guide for educators of adults,* 2nd edition*.* San Francisco: Jossey-Bass.

Creative Research System. 2014. Sample size calculator – *Confidence level, Confidence interval, Sample size, Population size, Relevant population.* The Survey System Packages. Retrieved from, www.surveysystem.com/resource/ [Accessed 17 October 2015].

Creswell, J.W. & Plano Clark, V.L. 2011. *Designing and conducting mixed methods research.* Thousand Oaks, CA: Sage Publication.

Creswell, J.W. 2014. *Research design. Qualitative, quantitative and mixed methods approaches,* 4th edition*.* Thousand Oaks, CA: Sage Publication.

Creswell, J.W., Fetters, M.D. & Curry, L.A. 2013. Achieving integration in mixed methods designs: Principles and practices. *Health Services Research*, 48(6), 2134-2156.

Cucu, M.C. & Lenta, O.E. 2014. Philosophical pragmatism in the digital era. *Postmodern Openings*, 5(1), 31-40.

Curry, L.A., Nembhard, I.M. and Bradley, E.H. 2009. *Qualitative and mixed methods provide unique contributions to outcomes research.* New Haven: American Heart Association.

Darling-Hammond, L. 2006. Constructing 21st century teacher education. *Journal of Teacher Education*, 57(3), 300-314.

De Neve, D., Devos, G. & Tuytens, M. 2015. The importance of job resources and self-efficacy for beginning teachers' professional learning in differentiated instruction. *Teaching and Teacher Education*, 47, 30-41.

De Vaus, D.A. 2002. *Surveys in social research,* 5th edition. Crows Nest, Australia: Allen & Unwin.

Denzin, N.K. & Lincoln, Y.S. 2011. *The Sage handbook of qualitative research,* 4th edition*.* Thousand Oaks, CA: Sage Publications.

Depaepe, F., Torbeyns, J., Vermeersch, N., Janssens, D., Janssen, R., Kelchtermans, G., Verschaffel, L. & Dooren, W.V. 2015. Teachers' content and pedagogical content knowledge on rational numbers: A comparison of prospective elementary and lower secondary school teachers. *Teaching and Teacher Education*, 47, 82-92.

Devers, K.J. & Kelly, J. 2000. Study design in qualitative research-2: Sampling and data collection strategies*. Education for Health*, 13(2), 263-271.

Diko, N. & Feza, N. 2014. Training of mathematics teachers in a South African university. *Mediterranean Journal of Social Sciences*, 5(23), 1456-1464.

Edens, K.M. 2000. Promoting communication, inquiry, and reflection in an early practicum experience via on-line discussion group. *Action in Teacher Education* 22(2), 14-23.

Eisenhardt, S., Besnoy, K. & Steele, E. 2012. Creating dissonance in pre-service teachers' field experiences. *SRATE Journal*, 21(1), 1-10.

Eisner, E.W. 1991. *The enlightened eye. Qualitative inquiry and the enhancement of educational practice.* New York, NY: Macmillan Publishing Company.

Endeley, M.N. 2014. Teaching practice in Cameroon: The effectiveness of the University of Buea model and implications for quality*. Australian Journal of Teacher Education*, 39(11), 147-160.

English, L.D. & Kirshner, D. 2010. *Handbook of international research in mathematics education.* New York: Routledge.

Evans, B.R. 2011. *Content knowledge, Attitudes and self-efficacy in the mathematics.* New York City Teaching Fellow (NYCTF) program, school science and mathematics 111(5), 225-235. Gess-Newsome, J. 1999. Secondary teachers' knowledge and beliefs about subject matter and their impact on instruction. In *Gess-Newsome, J. & Lederman*, N. (Eds), examining pedagogical content knowledge, pp. 51-94. Dordecht: Kluwer Academic Publishers.

Evans, S., Jones, I. & Dawson, C. 2014. *Do subject specialists produce more useful feedback than non-specialists when observing mathematics lessons?* Canada: Nottingham e-Prints.

Farrell, T.S.C. 2008. *Classroom management.* Alexandria, VA: TESOL publications.

Feiman-Nemser, S. & Buchmann, M. 1983. *Pitfalls of experience in teacher preparation.* Michigan, USA: Michigan State University.

Feiman-Nemser, S. 2001. From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers' College Record*, 103(6), 1013-1055.

Feuer, M.J.; Floden, R.E.; Chudowsky, N. & Ahn, J. 2013. *Evaluation of teacher preparation programs: Purposes, methods and policy options*. Washington, DC: National Academy of Education.

Field, A.P. 2006. *Research methods 2: Reliability analysis.* London: Sage

Publications.

Floden, R.E & Meniketti, M. 2005. Research on the effects of coursework in the arts and sciences and in the foundations of education. In M. Cochran-Smith & K.M. Zeichner (Eds.). *Studying teacher education: The report of the AERA Panel on Research and Teacher Education*. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers. pp. 261-308.

Fong, C.J. 2014. The effects of negative feedback on Motivation: A meta-analytic investigation. Unpublished dissertation. Austin, TX: University of Texas.

Fox, A.R.C. & Wilson, E.G. 2015. Networking and the development of professionals: Beginning teachers building social capital*. Teaching and Teacher Education*, 47, 93-107.

Fraenkel, J.R. & Wallen, N.E. 2006. *How to design and evaluate research in education*. Columbus, OH: Mcgraw-Hill Education.

Francis, S. 2008. *Time Management for Teachers.* Retrieved from: www.timemanagementforteachers.com.au, Australia.

Francis-Seton, A.I.N. 2011. Impact of collective responsibility on student learning and achievement. Unpublished dissertation. Minneapolis, MN: Walden University.

Franke, M.L. & Kazemi, E. 2001. *Learning to teach mathematics: Focus on student thinking. Theory into Practice*, 40(2), 102-109.

Fried, L. 2011. Teaching teachers about emotion regulation in the classroom*. Australian Journal of Teacher Education*, 36(3), 1-11.

Frydaki, E. & Mamoura, M. 2011. How can practicum experience transform preservice teachers' knowledge about teaching and learning*. The International Journal of the Humanities*, 9(1), 225-236.

Fuller, F. & Brown, O. 1975. Becoming a teacher. In *Teacher education: Seventy-fourth year book of the national society for the study of education*, ed. Ryan, K. 25-52. Chicago: University of Chicago press.

Gan, Z. 2013. *Learning to teach English language in the practicum: What challenges do non-native ESL student teachers face?* Hong Kong: The Hong Kong Institute of Education.

Ganser, T., Bainer, D.L., Bendixen-Noe, M., Brock, B.L., Stinson, A.D., Giebelhaus, C. & Runyon, C.K. 1998. Critical issues in mentoring and mentoring program for beginning teachers. A symposium presented at the annual meeting of the

Mid-Western Educational Research Association, Chicago.

Gilbert, K.R. 2001. *The emotional nature of Qualitative Research.* Boca Raton: CRC press.

Girvan, C. & Savage, T. 2012. Ethical considerations for educational research in a virtual world. *Interactive Learning Environments,* 20(3), 239-251.

Gleason, J. 2010. Reliability of the content knowledge for teaching-mathematics instrument for pre-service teachers. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, 1, 1-12.

Goh, P.S. & Matthews, B. 2011. Listening to the concerns of student teachers in Malaysia during teaching practice. *Australian Journal of Teacher Education*, 36(3), 12-23.

Goh, P.S.C. & Blake, D. 2015. Teacher preparation in Malaysia: Needed changes. *Teaching in Higher Education*, 20(5), 469-480.

Golafshani, N. 2003. Understanding reliability and validity in qualitative research. *The Qualitative Report*, 8(4), 597-606.

Gomm, R. 2004. *Social research methodology: A critical introduction*. Basingstoke: Palgrave. Macmillan.

Goodnough, K., Osmond, P., Dibbon, D., Glassman, M. & Stephens, K. 2009. Exploring a triad model of students teaching: Pre-service teachers and cooperating teachers' perceptions. *Teaching and Teacher Education*, 25(2), 285-296.

Gosnell, J.C. 2012. Academic self-efficacy, faculty-student interactions student characteristics as predictors of grade point average. Unpublished PhD thesis. Miami, FL: Barry University.

GroBschedl, J., Mahler, D., Kleickmann, T. & Harms, U. 2014. Content related knowledge of biology teachers from secondary schools: Structure and learning opportunities. *International Journal of Science Education*, 36(14), 2335-2366.

Grouws, D.A., Howald, C.L. & Colangelon, N. 1996. *Students' conceptions of mathematics: A comparison of mathematically talented students and typical high school algebra students.* New York: American Educational Research Association.

Guba, E.G & Lincoln, Y.S. 2005. *Paradigmatic controversies, contradictions and emerging confluences.* Thousand Oaks: Sage Publications.

Guba, E.G. 1990. *The paradigm dialogue.* London: Sage Publications.

Gulamhussein, A. 2013.*Teaching the teachers: Effective professional development in an era of high stakes accountability.* Alexandria, VA: Center for Public Education.

Hall, R. 2012. *Mixed methods: In search of a paradigm.* Sydney, Australie. The University of New South Wales.

Hamaidi, D., Al-Shara, I., Arouri, Y. & Abu Awwad, F. 2014. Student teachers' perspectives of practicum practices and challenges. *European Scientific Journal*, 10(13), 191-214.

Hancock, B. 2002. *An introduction to qualitative research.* Yorkshire/Humber: National Institute for Health Research.

Harrison, F. 2003. *Using learning resources to enhance teaching and learning.* London: Centre for Educational Development/Imperial College.

Haser, C. 2010. Learning to teach in the national curriculum context. *European Journal of Teacher Education*, 33(3), 293-307.

Hassan, Z.A., Schattner, P. & Mazza, D. 2006. *Doing a pilot study: Why it is important.* Australia: Monash University.

He, W., Means, T. & Lin, G.T. 2006. Field experience tracking and management in teacher development programs. *International Journal of Technology in Teaching and Learning*, 2(2), 134-147.

Hiebert, J., Morris, A.K. & Glass, B. (2003). Learning to "learn to teach": An "experiment" model for teaching and teacher preparation in mathematics. *Journal of Mathematics Teacher Education*, 6, 201-222.

Hill, H.C., Ball, D.L. & Schilling, S.G. 2008. Unpacking pedagogical content knowledge: Conceptualising and measuring teachers' topic specific knowledge of students. *Journal for Research in Mathematics Education*, 39(4), 372-400.

Hill, H.C., Rowan, B. & Ball, D.L. 2005. Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal,* 42(2), 371-406.

Hine, G.S.C. 2015. Strengthening pre-service teachers' mathematical content knowledge. *Journal of University Teaching and Learning Practice*, 12(4), article 5.

Hollins, E.R., Luna, C. & Lopez, S. 2014. Learning to teach teachers. *Teaching Education*, 25(1), 99-124.

Holloway, J. 2001. The benefits of mentoring. *Educational Leadership*, 58(8), 85-86.

Holm, J. & Kajander, A. 2012. Interconnections of knowledge and beliefs in teaching mathematics. *Canadian Journal of Science, Mathematics and Technology Education*, 12(1), 7-21.

Hossain, D.M. 2011 Qualitative research process. *Post Modern Openings,* 7, 143-156.

Howey, K. 1986.*The next generation of teacher preparation programs*. Washington, DC: American Association of Colleges for Teacher Education.

Hudson, L. & Ozanne, J. 1988. Alternative ways of seeking knowledge in consumer research. *Journal of Consumer Research*, 14(4), 508-521.

Hudson, P. & Hudson, S. 2010. Mentor educators' understanding of mentoring pre-service primary teachers. *International Journal of Learning*, 17(2), 157-170.

Hudson, P. 2016. Forming the mentor-mentee relationship. *Mentoring & Tutoring: Partnership in Learning,* 24(1), 30-43.

Hurrell, D.P. 2013. What teachers need to know to teach mathematics: An argument for a reconceptualised model. *Australian Journal of Teacher Education*, 38(11), 53-64.

Huseyin, H. 2009. Questionnaires and interviews in educational research. *Journal of Graduate School of Social Sciences*, 13(1), 201-216.

Incecay, G. 2011. Effects of learning beliefs of pre-service teachers at an English as a foreign language certificate program on their practice teaching. *Turkish Online Journal of Qualitative Inquiry*, 2(4), 29-38.

Ishler, R.E., Edens, K.M. & Berry, B.W. 1996. *Elementary education. Handbook of research on teacher education*. New York: MacMillan.

Ivankova, N.V. 2014. Implementing quality criteria in designing and conducting a sequential QUAN-QUAL mixed methods study of students' engagement with learning applied research methods online. *Journal of Mixed Methods Research*, 8(1), 1-27.

Jarret, D. 1998. *Integrating technology into middle school mathematics. It's just good teaching*. Northwest Regional Educational Laboratory. Retrieved January 12,

2016 from http://www.nwrel.org/msec/book6.pdf.

Jaworski, B. 2006. Theory and practice in mathematics teaching development: Critical inquiry as a mode of learning in teaching. *Journal of Mathematics Teacher Education*, 9(2), 187-211.

Jita, L.C. & Mokhele, M.L. 2013.The role of lead teachers in instructional leadership: A case study of environmental learning in South Africa. *Education as Change*, 17(S1) S123-S135.

Johnson, N. H. & Atwater, M. M. 2014. The impact of beliefs and actions on the infusion of culturally relevant pedagogy in science teacher education. In *Multicultural Science Education,* pp. 81-102. Springer Netherlands.

Joram, E. & Gabriele, A.J. 1998. Pre-service teachers' prior beliefs: Transforming obstacles into opportunities. *Teaching and Teacher Education,* 14(2), 175-191.

Jusoh, Z. 2012. *Teaching practicum: Student teachers' perspectives.* Malaysia: University Sultan Zainal.

Kagan, D.M. 1992. Professional growth among pre-service teachers and beginning teachers. *Review of Educational Research*, 62(2), 129-169.

Kahan, J., Cooper, D. & Bethea, K. 2003. The role of mathematics teachers' content knowledge in their teaching: A framework for research applied to a study of student teachers. *Journal of Mathematics Teacher Education*, 6(3), 223-252.

Kajander, A. 2005. Moving towards conceptual understanding in the pre-service classroom: A study of learning fractions: A study of evolving knowledge and values. 27th annual meeting of the North American chapter of the international group for the psychology of mathematics education, Roanoke: University of Virginia. Norton, S. 2010. How deeply and how well? How ready to teach mathematics after a one-year program? *Mathematics Teacher Education and Development*, 12(1), 65-84.

Katz, L.G. 1995. *Talks with teachers of young children: A collection*. Norwood, NJ: Ablex Publishing Corporation.

Kawulich, B.B. 2005. Participant observation as a data collection method. *Forum: Qualitative Social Research*, 6(2).

Kelley, K., Clark, B., Brown, V. & Sitzia, J. 2003. Good practice in the conduct and reporting of survey research. *International Journal for Quality in Health Care*, 15(3), 261-266.

Kelly, S. & Tannehill, D. 2012. The mentoring experience of an Irish student teacher on his physical education teaching practicum. *Graduate Journal of Sports, Exercise and Physical Education Research*, 1, 47-64.

Kennedy, M.M. 2002. Knowledge and teaching [1]. *Teachers and Teaching: Theory and practice*, 8(3), 355-370*: Carfax publishing*:

Kessel, C. 2009.*Teaching teachers mathematics: Research, ideas, projects, evaluation. Critical issues in mathematics education series*. Berkeley, California: Mathematical research Institute (MSRI).

Kiggundu, E. & Nayimuli, S. 2009. Teaching practice: A make or break phase for student teachers*. South African Journal of Education*, 29, 345-358.

Kim, Y.R., Ham, S. & Paine, L.W. 2011. Knowledge expectations in mathematics teacher preparation programs in South Korea and the United States: Towards international dialogue. *Journal of Teacher Education*, 62(1), 48-61.

Kleickmann, T., Richter, D., Kunter, M., Elsner, J., Besser, M., Krauss, S. & Baumert, J. 2013. Pedagogical content knowledge and content knowledge of mathematics teachers: The role of structural differences in teacher education. *Journal of Teacher Education*, 64(1), 90-106.

Kline, P. 1999. The handbook of psychological testing. London and New York: Routledge.

Koelsch, L.E. 2013. Reconceptualising the member check interview. *International Journal for Qualitative Methods*, 12, 168-179.

Kumar, R. 2014. *Research methodology: A step-by-step guide for beginners*. Australia: Sage Publications.

Kusure, L.P. & Basira, K. 2012. *Instruction in science and mathematics for the 21st century*. Bindura, Zimbabwe: Bindura University of Science Education.

Lampert, M. 1990. When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal*, 27(1), 29-63.

Ledford, G.E., Gerhart, B. & Fang, M. 2013. Negative effects of extrinsic rewards on intrinsic motivation: More smoke than fire. *WorldatWork Journal*, 22(2), article 2.

Lee, K.E.C. 2003. Research on learning to teach: Lessons for the professional preparation of pre-service geography teachers at NIE/Singapore. *International Research in Geographical and Environmental Education*, 12(3), 275-283.

Leedy, P.D. & Omrod, J.E. 2013. *Practical research: Planning and design,* 10th edition. USA: Pearson Education.

Leikin, R. & Levav-Waynberg, A. 2009. Development of teachers' conceptions through learning and teaching: Meaning and potential of multiple-solutions tasks. *Canadian Journal of Science, Mathematics and Technology Education*, 9(4), 203-223.

Leikin, R. & Zazkis, R. 2010. Learning through teaching mathematics: Development of teachers' knowledge and expertise in practice. *Mathematics Teacher Education*, vol 5. London: Springer Science + Business Media B.V.

Leithwood, K. 2006. *Teacher working conditions that matter: Evidence for change.* Toronto: Elementary Teachers' Federation of Ontario.

Leke-ateh, B.A., Assan, T.E.B. & Debeila, J. 2013. Teaching practice for the 21st Century: challenges and prospects for teacher education in the North-West province. *Journal for Social Sciences*, 37(3), 279-291.

Lincoln, Y.S. & Guba, E.G. 1985. *Naturalistic inquiry*: Beverly Hills, CA: Sage.

Lipton, L. & Wellman, B. 2014. *Learning-focused supervision: Developing professional expertise in standards-driven systems*. Mira Via, LLC.

Liu, Y. & Huang, C. 2005. Concerns of teachers about technology integration in the USA. *European Journal of Teacher Education*, 28(1), 35-47.

Livy, S.L., Vale, C. & Herbert, S. 2016. Developing primary pre-service teachers' mathematical content knowledge during practicum teaching. *Australian Journal of Teacher Education*, 41(2), 152-173.

Lo, W.Y. & Anderson, J. 2010. Beyond the curriculum: The mathematical beliefs of pre-service primary teachers in Hong Kong. *Paper presented at the annual meeting of the Mathematics Education Research Group of Australasia*, Freemantle, Western Australia.

Lopez-Fernandez, O. & Molina-Azorina, J.F. 2011. The use of mixed methods research in interdisciplinary educational journals. *International Journal of Multiple Research Approaches*, 5(2), 269-283.

Lowrie, T. & Jorgensen, R. 2015. *Pre-service teachers' mathematics content knowledge: Implications for how mathematics is taught in higher education.* Australia: University of Canberra.

Majongwe, R. 2013. *Zimbabwe education unions deplore use of temporary unqualified teachers.* Available at [Accessed 29 June 2016].

Manzar-Abbas, S. & Lu, L. 2013. Student teachers' perceptions about the curriculum content: A case of a normal university in China. *Education as Change*, 17(1), 37-52.

Maphosa, C., Shumba, J. & Shumba, A. 2007. Mentorship for students on teaching practice in Zimbabwe: Are student teachers getting a raw deal? *South African Journal of Higher Education*, 21(2), 296-307.

Marshall, C. & Rossman, G.B. 2011. *Designing qualitative research,* 5th edition. Amherst: Sage publications.

Martin, D. 1998. *Student teachers' practices in primary school mathematics.* Canada: Rouyn-Noranda QC.

McDiarmid, W. & Ball, D.L. 1998. *The teacher education and learning to teach study (TELT): An occasion for developing a conception of teacher knowledge.* Michigan: College of Education, Michigan State University.

Mergler, A. & Spooner-Lane, R. 2012. What pre-service teachers need to know to be effective at values-based education. *Australian Journal of Teacher Education*, 37(8), 66-81.

Merriam, S.B. 2009. *Qualitative research: A guide to design and implementation:* San Francisco: Jossey-Bass.

Michel, C.M. 2008. Implementing a forensic educational package for registered nurses in two emergency departments in Western Australia. Unpublished PhD thesis. Sydney, Australia: University of Notre Dame Australia.

Milne, J. 1999. Questionnaires: Advantages and disadvantages. In: Evaluation cookbook. *Centre for CBL in land use and environment Sciences*. Aberdeen University
http://www.icbl.hw.ac.uk/ltdi/cookbook/info_questionnaires/index.html.
[Accessed on 15 June 2016].

Ministry of Education, Government of Guyana. 2015. *Components of effective teaching: Eliminating illiteracy, modernising Education, strengthening tolerance.*

Ministry of Education, Sport and Culture, Higher and Tertiary Education Zimbabwe 2004. The development of education, National report of Zimbabwe. *Presentation at the 47th session of the international conference on Education.* Geneva. Switzerland.

Mokhele, M.L. & Jita, L.C. 2011. South African teachers' perspectives on continuing

professional development: A case study of the Mpumalanga secondary science initiative. *Social and Behavioural Sciences, 9, 1762-1766.*

Moore, J. 2005. Transformative mathematics pedagogy: From theory to practice, research and beyond. In A.J. Rodriguez & R.S. Kitchen (Eds.). *Preparing mathematics and science teachers for diverse classrooms.* Mahaw, New Jersey: Lawrence Erlbaum.

Morse, J.M. & Richards, L. 2002. *Readme first for a user's guide to qualitative methods.* Thousand Oaks, CA: Sage Publications.

Mosvold, R. & Fauskanger, J. 2014. Teachers' beliefs about mathematical horizon content knowledge. *International Journal for Mathematics Teaching and Learning,* 9(3), 311-327.

Muir, T., Allen, J.M., Rayner, C.S. & Clelan, B. 2013. Preparing pre-service teachers for classroom practice in a virtual world: A pilot study using second life. *Journal of Interactive Media in Education,* 1, 1-17.

Mukeredzi, T.G. 2013. The journey to becoming teaching professionals in rural South Africa and Zimbabwe. *Australian Journal of Teacher Education*, 38(10), 83-104.

Murray-Harvey, R., Slee, P.T., Lawson, M.J., Halia Silins, Banfield, G. & Russell, A. 2000. Under stress: The concerns and coping strategies of teacher education students. *European Journal of Teacher Education*, 23(1), 19-35.

Nahal, S.P. 2009. *Exploring disparities between teachers' expectations and the realities of the education profession.* Phoenix, Arizona: University of Phoenix.

National Commission on Excellence in Education (Ed.). 1983. *A Nation at Risk: The Imperative for Education Reform.* Washington, DC, U.S. Department of education.

National council for accreditation of teacher education (NCATE). 2008. *Professional standards for the accreditation of teacher preparation institutions.* Washington DC: NCATE.

National focus Group on Teaching of Mathematics 2006. *National council of educational research and training.* New Delhi: National focus Group on Teaching of Mathematics.

Nespor, J. 1987. The role of beliefs in the practice of teaching. *Journal of Curriculum Studies*, 19(4), 317-328.

Nestojko, J.F., Bui, D.C., Kornell, N. & Bjork, E.L. 2014. Expecting to teach

enhances learning and organisation of knowledge in free recall of text passages: *Memory and Cognition Journal,* 42, 1038-1048.

Newmann, F.M. & Wehlage, G.G. 1995. *Successful school restructuring: A Report to the public and educators by the Centre on Organisation and Restructuring of Schools.* Madison, Wisconsin: CORS.

Newton, N. 2010. The use of semi-structured interviews in qualitative research: Strengths and weaknesses. Bristol: University of Bristol.

Nicol, C. & Crespo, S. 2003. *Learning in and from practice: Pre-service teachers investigate their mathematics teaching.* Vancouver, Canada: University of British Columbia.

Noel, N.A.M. 2007. Problems faced by pre-service teachers during teaching practice: A survey on PKPG ESL. PKPG science and B.Ed. TESL undergraduates. Unpublished dissertation. Sarawak, Malaysia: University of Malaysia.

O'Neil, R. 2006. *The advantages and disadvantages of qualitative and quantitative research methods.* http://ww1.roboneill.co.uk (online: Rob O' Neill website) [Accessed 27 June 2016].

Oliver, R.M. & Reschly, D.J. 2007. *Effective classroom management: Teacher preparation and professional development.* Washington, DC: National Comprehensive Centre for Teacher Quality.

Oonk, W. 2009. *Theory-enriched practical knowledge in mathematics teacher education.* Leiden: Leiden University Graduate School of Teaching: ICLON.

Organisation for Economic Cooperation and Development (OECD). 2009*. Education at a glance.* Paris, France: OECD Publications.

Palsdottir, G., Gunnarsdottir, G.H. & Kristinsdottir, J.V. 2008. *Theory and practice in mathematics teacher education. Building a learning community.* Reykjavík, Iceland: University of Iceland.

Patton, M.Q. 2002. *Qualitative evaluation methods.* Beverly Hills: Sage Publications.

Peake, G. 2006. *Observation of the practice of teaching.* Huddersfield, UK: PCET Consortium, University of Huddersfield.

Pearson, L.C. & Hall, B.C. 1993. Initial construct validation of the teaching autonomy scale. *Journal of Educational Research,* 86(3), 172-178.

Peressin, D., Borko, H., Romagnano, L., Knuth, E. & Willis-Yorker, C. 2004. A conceptual framework for learning to teach secondary mathematics. A

situative perspective. *Educational Studies in Mathematics*, 56, 67-96. Netherlands: Kluwer Academic Publishers.

Perry, R. 2004. *Teaching Practice for early childhood. A Guide for Students*. London and New York: RoutledgeFalmer.

Peters, J.H. 2012. Are they Ready? Final year pre-service teachers' learning about managing student behaviour*. Australian Journal of Teacher Education*, 37((), 18-42.

Puckett, J.B. & Anderson, R.S. 2002. Assessing field experience*. New directions for Teaching and Learning,* 91, 53-60.

Quick, G. & Sieborger, R. 2005. What matters in practice teaching? The perception of schools and students. *South African Journal of Education*, 25(1), 1-4.

Rahman, F.A., Scaife, J. & Yahya, N.A. 2010. Pre-service teachers' voices while learning to teach: What can be learned from England? *Pertanika Journal of Social Sciences and Humanities*, 18(1), 187-198.

Rakicioglu-Soylemez, A. & Eroz-Tuga, B. 2014. Mentoring expectations and experiences of prospective and cooperating teachers during practice teaching. *Australian Journal of Teacher Education*, 39(10), 146-168.

Randall, I.C. & Carmel, C.A. 2005. Big ideas and understandings as the foundation for elementary and middle school mathematics. *Journal of Mathematics Education Leadership*, 8(1), 9-22.

Regan, J.A., Baldwin, M.A. & Peters, L. 2014. Ethical issues in pedagogical research. *Journal of Pedagogic Development*, 2(3).

Remiliard, J.T. 2009. Considering what we know about the relationship between teachers and curriculum material. In Remilliard, J.T. Herbel-Eisenmann, B.A. & Lloyd, G.M. (Eds.). *Mathematics teachers at Barbosa & Oliveira work: Connecting curriculum materials and classroom instruction/editors*. New York, NY: Routledge.

Rena, R. 2010. Review of higher education in Africa, perception of pre-service teachers towards teaching: A case study on the Eritrea Institute of Technology. *Review of Higher Education in Africa*, 2(1).

Resnick, D.B. 2010. Scientific research and the public trust. *Science and Engineering Ethics,* 17(3), 399-409.

Rice, J.K. 2003. *Teacher quality: Understanding the effectiveness of teacher attributes.* Washington, DC: Economic Policy Institute.

Richardson, V. 1996. The role of attitudes and beliefs in learning to teach. In Sikula, J. Buttery, T.J. & Guyton, E. (Eds.). *Handbook of research on teacher education,* (second edition), 102-119. New York. Macmillan.

Richardson-Koehler, V. 1987. What happens to research on the way to practice? *Theory Into Practice*, 26(1), 38-43.

Ritchie, J. & Lewis J. 2003. *Qualitative research practice: A guide for social sciences students and researchers.* Thousand Oaks/New Delhi: Sage Publications.

Rosemary, N., Richard, N. & Ngara, R. 2013. Talk about teaching practice supervision as a quality assurance tool in teacher training: Perceptions of prospective teachers at Masvingo teachers' training colleges. *European Social Sciences Research Journal*, 1(1), 1-10.

Rozenszajn, R. & Yarden, A. 2014. Mathematics and biology teachers' tacit views of the knowledge required for teaching: Varying relationships between content knowledge and pedagogical content knowledge*. International Journal of STEM Education,* 1(11), 1-12.

Russell, M. & Russell, J.A. 2014. Pre-service teachers and cultural diversity awareness*. Electronic Journal of Science Education*, 18(3), 1-20.

Russell-Bowie, D.E. 2012. Developing pre-service primary teachers' confidence and competence in arts education using principles of authentic learning. *Australian Journal of Teacher Education*, 37(1), 60-74.

Saban, A. & Cocklar, A.C. 2013. Pre-service teachers' opinions about the micro-teaching method in teaching practice classes*. The Turkish Journal of Educational Technology*, 12(2), 234-240.

Sag, R. 2014. *The course of pre-service teachers' expectations in school practices and the factors affecting their expectations*. Turkey: Creative Education.

Sanger, M. & Osguthorpe, R. 2010. Teacher candidate beliefs regarding the moral work of teaching. *Paper present at the annual conference of the American Education Research Association*, Denver, CO.

Santagata, R., Zannoni, C. & Stigler, J.W. 2007. The role of lesson analysis in pre-service teacher education. An empirical investigation of teacher learning from a virtual video-based field experience*. Journal of Mathematics Teacher Education*, 10(2), 123-140.

Schmelzing, S., Van Driel, J.H., Juttner, M., Brandenbush, S., Sandmann, A. & Neuhaus, B.J. 2013. Development, evaluation, and validation of a paper-and-

pencil test for measuring two components of biology teachers' pedagogical content knowledge concerning the "cardiovascular system". *International Journal of Science and Mathematics Education*, 11(6), 1369-`390.

Schmidt, W.H. & Maier, A. 2009. Opportunity to learn. In Sykes, G. Schneider, B.L. & Plank, D.N. (Eds.). *Handbook on education policy research*. Routledge: New York, New York.

Schneider, R.M. & Plasma, K. 2011. Science teacher learning progressions: A review of science teachers' pedagogical content knowledge development. *Review of Educational Research*, 81(4), 530-565.

Schonfeld, A.H. 1992. Learning to think mathematically, problem solving, metacognition and sense making in mathematics. In In D. Grouws (Ed.). *Handbook for research on mathematics teaching and learning*. New York: MacMillan. (pp. 334-370).

Scribner, J.P. & Akiba, M. 2010. Exploring the relationship between prior career experience and instructional quality among mathematics and science teachers in alternative teacher certification programs. *Educational Policy*, 24(4), 602-627.

Sheafer, V. 2014. *Using service learning to teach classic learning theories*. Texas: Le Tourneau University.

Shoaf, L.M. and Shoaf, M.G. (2006). The hidden Advantages of Focus Group Interviews in Educational Research *journal of* school public relations, 27, 343-353.

Shulman, L.S. 1986. Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4-14.

Shulman, L.S. 1987. Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1-21.

Shulman, L.S. (2003). A different way to think about teaching and learning. Learning to teach: Sharing the Wisdom of Practice. *The Carnegie Foundation for the Advancement of Teaching*. SAGE publications.

Silva, C.N. 2008. Review: Designing qualitative research. Forum: Qualitative Social Research, 9(3).

Simon, M.A. 1997. Developing new models of mathematics teaching: An imperative for research on mathematics teacher development. In Fennema, E. & Nelson, B.S. (Eds.), *Mathematics Teachers in Transition,* pp. 55-86. Mahwah, NJ:

Erlbaum.

Simon, M.K. 2011. *Dissertation and scholarly research: Recipes for success.* Seattle, WA: Dissertation Success, LLC.

Siniscalco, M.T. & Auriat, N. 2005. *Questionnaire design: Quantitative research methods in educational planning.* Paris, France: International Institute for Educational Planning/UNESCO.

Sivo, S.A., Saunders, C., Chang, Q. & Jiang, J.J. 2006. How long should you go? Low response rate and the validity of inference in IS questionnaire research. *Journal of the Association for Information Systems*, 7(6), 351-414.

Skinner, C.H., Pappas, D.N. & Davis, K.A. 2005. Enhancing Academic Engagement Providing Opportunities for Responding and Influencing Students to Choose to respond. *Psychology in the Schools,* 42, 389-403.

Smith, M.C. 1991. *Reinventing student teaching.* USA: Sage Publications.

Snyder, C. 2012. Finding the "royal road" to learning to teach: listening to novice teacher voices in order to improve the effectiveness of teacher education. *Teacher Education Quarterly,* 39(4), 33-53.

Southern African Regional Universities Association (SARUA). 2009. *Towards a common future: Higher education in the SADC region* Tanzania: SARUA.

Soylemez, A.R. & Tuga, A.I. 2014. Mentoring expectations and experiences of prospective and cooperating teachers during practice teaching. *Australian Journal of Teacher Education*, 39(10), 146-168.

Spratt, C. Walker, R. & Robinson, B. 2004. *Module A5: Mixed-methods research.* Cambridge: Commonwealth of Learning.

Steinbring, H. 1998. Elements of epistemological knowledge for mathematics teachers. *Journal of Mathematics and Teacher Education*, 1(2), 157-189.

Stenner, J., Rock, A. & Donald, A. 2005. Assessment issue in the testing of children at school entry. *The Future of Children Journal,* 15(1), 15-34.

Stofflet, R. & Stoddart, T. 1994. The ability to understand and use conceptual change pedagogy as a function of prior content learning experience. *Journal of Research in Science Teaching*, 31(1), 31-51.

Stoll, L., Bolam, R., McMiahon, A., Waalace, M. & Thomas, S. 2006. Professional learning communities: A review of the literature. *Journal of Educational Change*, 7(4), 221-258.

Stroot, S., Keil, V., Stedman, P., Lohr, L., Faust, R., Schincariol-Randall, L., Sullivan, A., Czerniak, G., Kuchcinski, J., Orel, N. and Richter, M. 1998. *Peer assistance and Review Guide Book.* Columbus, OH: Ohio Department of education.

Supovitz, J., Ebby, C.B., Sirinides, P. & Oettinger, A. 2013. *Teacher analysis of student knowledge (TASK): A measure of learning trajectory-oriented formative assessment.* San Francisco: Consortium for Policy Research in Education (CPRE).

Taber, S.B. 1998. Learning to teach mathematics differently: The effect of "investigations" curriculum on teachers' attitudes and practices. *Paper presented at the Annual Meeting of the American Educational Research Association,* San Diego, CA.

Tan, Y.H. 2008. English teacher trainees' voices describe their teaching practicum experience. *Journal Penyelidikan Pendidikan* IPTAR, 120-136.

Tarman, B. 2012. Prospective teachers' beliefs and perceptions about teaching as a profession. *Educational Sciences: Theory and Practice*, 12(3), 1964-1973.

Tashakkori, A. & Teddlie, C. 2009. *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social behavioural sciences.* Thousand Oaks, CA: Sage Publications.

Tatto, M.T. & Senk, S. 2011. The mathematics education of future primary and secondary teachers: Methods and findings from the teacher education and development study in mathematics. *Journal of Teacher Education*, 62(2), 121-137.

Tavakol, M. & Dennik, R. 2011. Making sense of Cronbanch's alpha. *International Journal of Medical Education*, 2, 53-55.

Taylor, B., Kermode, S. & Roberts, K. 2007. *Research in nursing and health care: Evidence for practice,* 3rd edition. Sydney: Thomson

Terrell, S.R. 2012. Mixed-methods research methodologies. *The Qualitative Report*, 17(1), 254-280.

Tsao, Y.L. 2005. The number sense of pre-service elementary teachers. *College Student Journal,* 39(4).

Tuckman, B.W. 1999. *Conducting educational research,* 5th edition. New York: The Ohio State University, Harcourt Brace College Publishers.

Turnuklu, E.B. & Yesildere, S. 2007. The pedagogical content knowledge in

mathematics: Pre-service primary mathematics teachers' perspectives in Turkey. *Issues in the Undergraduate Mathematics Preparation of School Teachers: The Journal*, 1, 1-13.

Unal, Z. & Unal, A. 2012. The impact of years of teaching experience on the classroom management approaches of elementary school teachers. *International Journal of Instruction*, 5(2), 42-60.

van den Bos, P. & Brouwer, J. 2014. Learning to teach in Higher Education: How to link theory and practice. *Teaching in Higher Education*, 19(7), 772-786.

Van Es, E.A. & Conroy, J. 2009. Using the performance assessment for California teachers to examine pre-service teachers' conceptions of teaching mathematics for understanding. *Issues in Teacher Education*, 18(1), 83-102.

Vanderlinde, R. & Braak, J.V. 2010. The gap between educational research and practice: Views of teachers, school leaders, intermediaries and researchers. *British Educational Research Journal*, 36(2), 299-316

Vanek, C. 2012. Likert Scale – What is it? When to use it? How to analyse it? Survey reports guide. [Web blog post], Retrieved from: http://www.surveygizmo.com/survey-blog/likert-scale-what-is-it-how-to-analyze-it-and-when-to-use-it/ [Accessed 15 January 2016]

Varatharaj, R., Abdullah, A.G.K. & Ismail, A. 2015. The effect of teacher autonomy on assessment practices among Malaysian cluster school teachers. *International Journal of Asian Social sciences*, 5(1), 31-36

Vesilind, E.M. & Jones, M.G. 1998. Gardens or graveyard: Science education reform and school culture. *Journal of Research in Science Teaching*, 35(7), 757-775.

Waghorn, A. & Stevens, K. 1996. Communication between theory and practice: How student teachers develop theories of teaching. *Australian Journal of Teacher Education*, 21(2), 70-81 .

Wagner, D.A. 2012. What should be learned from learning assessments? In: Wagner, D.A., Lockheed, M., Mullis, I., Martin, M.O., Kanjee, A., Gove, A. & Dowd, A.J. 2012. The debate on learning assessments in developing countries. *Compare: A Journal of Comparative and International Education*, 42(3), 509-545.

Wahlstrom, K.L. & Louis, K.S. 2008. How teachers experience principal leadership: The roles of professional community, trust, efficacy and shared responsibility. *Educational Administration Quarterly,* 44(4), 458-495.

Weaver, K. & Olson, J.K. 2006. Understanding paradigms used for nursing research. *Journal of Advanced Nursing*, 53(4), 459–469.

Webster, S., Lewis, J. & Brown, A. 2014. Ethical considerations in qualitative research. In *Qualitative Research Practice*: *A guide for social science students and researchers*. Pp. 77-107. London. Sage publications.

Weimer, M. 2008. *Effective teaching strategies: The importance of marrying content and process.* Madison, USA: Magna publications.

Weinstein, C.S. 1988. Pre-service teachers' expectations about the first year of teaching. *Teaching and Teacher Education*, 4(1), 31-40. Great Britain.

Weinstein, C.S. 1988. Pre-service teachers' expectations about the first year of teaching. *Teaching and Teacher Education*, 4(1), 31-40.

Wertheim, C. & Leyser, Y. 2002. Efficacy beliefs, background variables and differentiated instruction of Israeli prospective teachers. *The Journal of Educational Research*, 96(1), 54-63.

What matters most: Teaching for America's Future: Report of the national commission on teaching & America's future (NCTAF). 1996. *National Commission on teaching & America's Future*. New York, NY.

Wideen, M., Smith, J.M. & Moon, B. 1998. *A critical analysis of the research on learning to teach: Making the case for an ecological perspective on inquiry*. USA: American Educational Research Association.

Wood, T. & Sellers, P. 1996. Assessment of a problem centred mathematics program: Third grade. *The Journal of Research in Mathematics Education*, 27(3), 337-353.

Wu, H. 2014. *Building better Mathematics* Teachers. University of Califonia, Berkely. Retrieved from: https://math.berkely.edu [Accessed 20 August 2015]

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

Yin, R.K. 2011. *Qualitative research from start to finish.* New York, NY: United States: The Guilford Press.

Yong, A.G. & Pearce, S. 2013. A beginner's guide to factor analysis: Focusing on exploratory factor analysis. *Tutorials in Quantitative Methods for Psychology*, 9(2), 79-94.

Yong, T., Hua, M. & Feng-Mei, G. 2007. Empirical study on impact of logistics operations capability on supply chain performance. *The third international conference on wireless communications, networking and mobile computing,* Shanghai, China.

Zeichner, K.M. & Liston, D.P. 1987. Teaching student teachers to reflect*. Harvard Educational Review*, 56(1), 23-48.

Zevenbergen, R., Mousley, J. & Sullivan, P. 2004. Disrupting pedagogic relay in mathematics classrooms: Using open-ended Tasks with indigenous students. International Journal of Inclusive Education, 8(4), 391-405.

Zimbabwe schools examinations council (ZIMSEC) examination analysis, 2015. Retrieved from: http://www.zimsec.co.zw/zimsec-exams/results/76-ordinary-level-2015/, pp. 5 [Accessed 16 June 2016].

APPENDICES

APPENDIX 1: ETHICAL CLEARANCE: UNIVERSITY OF THE FREE STATE

Faculty of Education

30-Jun-2015

Dear Mrs Chipo Makamure

Ethics Clearance: Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

Principal Investigator: Mrs Chipo Makamure

Department: School of Education Studies (Bloemfontein Campus)

With reference to you application for ethical clearance with the Faculty of Education. I am pleased to inform you on behalf of the Ethics Board of the faculty that you have been granted ethical clearance for your research.

Your ethical clearance number, to be used in all correspondence is:

UFS-HSD2015/0273

This ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the ethics office to ensure we are kept up to date with your progress and any ethical implications that may arise.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely

Dr M.M. Nkoane
Chairperson: Ethics Committee
Faculty of Education

APPENDIX 2: REQUEST LETTERS TO CONDUCT RESEARCH

2A: Letter of permission to carry out research to the ministry of education Sport and Culture

                                                            538 Manombe Close

                                                            Helensvale

                                                            Borrowdale

                                                            Harare

The Ministry of Education, Sport and Culture

The Head Office

P. O Box 89

Causeway

Harare

Dear Sir/Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I hereby request permission to conduct research in selected schools within your districts (Harare & Bulawayo). My name is Chipo Makamure, and I am presently studying for a PhD degree with the University of the Free State. I am also Head of Department Natural Sciences, at Belvedere Technical Teachers' College. As part of my Doctoral programme, I am required to conduct research on an aspect of interest with a view to making a contribution to our knowledge and understanding of the issue under study. The title of my thesis is:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

The purpose of the study is to explore the significance and contribution of teaching

practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. The study, therefore, focuses on how pre-service teachers develop their mathematical knowledge of teaching through practice during the process of learning to teach. An understanding of how the process of "learning to teach" develops can create an opportunity for teacher education curriculum developers to design new curricular that are personally relevant to pre-service teachers' needs.

The study will involve pre-service teachers completing questionnaires before and during teaching practice. They may also be selected to participate in follow-up interviews at a time that is convenient to them. Semi-structured Interviews with selected mentors (school based) will also be carried out. The interviews may be audio taped if need be. Both the interviews and questionnaire completion are expected to last not more than an hour.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the schools and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they so wish.

Upon the completion of the study, I undertake to provide the Ministry of Education, Sport and Culture with a copy of the research report and to share my findings with the schools in the three provinces.

I attach a letter of recommendation from my research supervisor regarding the study and my progress. If you need any further information and/or have suggestions, please do not hesitate to contact me and/or my research supervisor:

 Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522.

Thank you for your kind consideration of my request.

Yours sincerely

Chipo Makamure

Cell: +263 772 432 465 (E-mail: makamburec@gmail.com)

2B: Letter of Permission to carryout research to the ministry of higher and Tertiary Education, Science and Technology Development

<div align="right">

538 Manombe Close

Helensvale

Borrowdale

Harare

</div>

The Ministry of Higher and Tertiary Education, Science and Technology

The Head Office

Harare

Dear Sir/Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I hereby request permission to conduct research in selected Teachers' Colleges within your districts (Harare & Bulawayo). My name is Chipo Makamure, and I am presently studying for a PhD degree with the University of the Free State. I am also Head of Department Natural Sciences, at Belvedere Technical Teachers' College. As part of my Doctoral programme, I am required to conduct research on an aspect of interest with a view to making a contribution to our knowledge and understanding of the issue under study. The title of my thesis is:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

The purpose of the study is to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. The study, therefore, focuses on how pre-service teachers develop their mathematical

knowledge of teaching through practice during the process of learning to teach. An understanding of how the process of "learning to teach" develops can create an opportunity for teacher education curriculum developers to design new curricular that are personally relevant to pre-service teachers' needs.

The study will involve pre-service teachers completing questionnaires before and during teaching practice. They may also be selected to participate in follow-up interviews at a time that is convenient to them. Semi-structured Interviews with selected teacher educators (college based) will also be carried out. The interviews may be audio taped if need be. Both the interviews and questionnaire completion are expected to last not more than an hour.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the colleges and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they so wish.

Upon the completion of the study, I undertake to provide the Ministry of Higher and Tertiary Education, Science and Technology with a copy of the research report and to share my findings with the teachers' colleges in all the districts.

I attach a letter of recommendation from my research supervisor regarding the study and my progress. If you need any further information and/or have suggestions, please do not hesitate to contact me and/or my research supervisor:

 Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522.

Thank you for your kind consideration of my request.

Yours sincerely

Chipo Makamure

Cell: +263 772 432 465 (E-mail: makamburec@gmail

2C: Letter of Permission to carryout research to the Teachers' College Principals

<div align="right">

538 Manombe Close

Helensvale

Borrowdale

Harare
</div>

The Principal

XXX Teachers' College

N0. 1 XXX road

XXXXX

Zimbabwe

Dear Sir/Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I hereby request permission to conduct research with selected lecturers in your college. My name is Chipo Makamure, and I am presently studying for a PhD degree with the University of the Free State. I am also Head of Department Natural Sciences, at Belvedere Technical Teachers' College. As part of my Doctoral programme, I am required to conduct research on an aspect of interest with a view to making a contribution to our knowledge and understanding of the issue under study. The title of my thesis is:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

The purpose of the study is to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. The study, therefore, focuses on how pre-service teachers develop their mathematical

knowledge of teaching through practice during the process of learning to teach. An understanding of how the process of "learning to teach" develops can create an opportunity for teacher education curriculum developers to design new curricular that are personally relevant to pre-service teachers' needs.

The study will involve pre-service teachers completing questionnaires before and during teaching practice. They may also be selected to participate in follow-up interviews at a time that is convenient to them. Semi-structured Interviews with selected teacher educators (college based) will also be carried out. Both the interviews and questionnaire completion are expected to last not more than an hour.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the college and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they so wish.

Upon the completion of the study, I undertake to provide the Ministry of Higher and Tertiary Education, Science and Technology with a copy of the research report and to share my findings with the teachers' colleges in all the districts.

I attach a letter of recommendation from my research supervisor regarding the study and my progress. If you need any further information and/or have suggestions, please do not hesitate to contact me and/or my research supervisor:

 Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522.

Thank you for your kind consideration of my request.

Yours sincerely

Chipo Makamure

Cell: +263 772 432 465 (E-mail: makamburec@gmail.com)

2D: Letter of Permission to carryout research to the School Headmasters where pre-service teachers are placed.

<div align="right">
538 Manombe Close

Helensvale

Borrowdale

Harare
</div>

The Head of School

XXX Secondary School

P. O Box XXX

XXXXXXXX

Dear Sir/Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I hereby request permission to conduct research with selected mathematics pre-service teachers at your school. My name is Chipo Makamure, and I am presently studying for a PhD degree with the University of the Free State. I am also Head of Department Natural Sciences, at Belvedere Technical Teachers' College. As part of my Doctoral programme, I am required to conduct research on an aspect of interest with a view to making a contribution to our knowledge and understanding of the issue under study. Permission has been granted me by the Ministry of Higher and Tertiary Education, Ministry of Education and the principals of the colleges from which the student teachers are trained, to conduct the study. The title of my thesis is:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

The purpose of the study is to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. The study,

therefore, focuses on how pre-service teachers develop their mathematical knowledge of teaching through practice during the process of learning to teach. An understanding of how the process of "learning to teach" develops can create an opportunity for teacher education curriculum developers to design new curricular that are personally relevant to pre-service teachers' needs.

The study will involve pre-service teachers completing questionnaires before and during teaching practice. They are also selected to participate in follow-up interviews at a time that is convenient to you. Both the interviews and questionnaire completion are expected to last not more than an hour. Please take note that the interviews may be audio taped if need be.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the school and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they so wish.

Upon the completion of the study, I undertake to share my findings with you, as a school.

I attach letters of recommendation from the Ministry of Higher and Tertiary Education, Ministry of Education and the participating colleges. If you need any further information and/or have suggestions, please do not hesitate to contact me and/or my research supervisor:

Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522.

Thank you for your kind consideration of my request.

Yours sincerely

Chipo Makamure

Cell: +263 772 432 465 (E-mail: makamburec@gmail.com)

APPENDIX 3: PERMISSION LETTERS

3A: Clearance Letter – Ministry of Higher & Tertiary Education Zimbabwe

All official communications should be addressed to
"The Secretary"

Reference:

MINISTRY OF HIGHER AND TERTIARY
EDUCATION, SCIENCE AND TECHNOLOGY
DEVELOPMENT

Telephone: 795891-5, 796441-9, 730055-9
Fax: 733070
Telegraphic address "EDUCATION"

ZIMBABWE

P.O. Box CY7732, Causeway

24 August 2015

538 Manombe Close
Helensvale
Borrowdale
Harare

Dear Ms C. Makamure,

APPLICATION FOR PERMISSION TO CONDUCT A STUDY ON "LEARNING TO TEACH SECONDARY SCHOOL MATHEMATICS FROM PRACTICE: AN EXPLORATION OF THE ZIMBABWEAN PRE-SERVICE TEACHERS' YEAR LONG FIELD EXPERIENCE"

Reference is made to your letter, in which you request for permission to carry out a research on "*Learning to Teach Secondary School Mathematics from Practice: An Exploration of the Zimbabwean Pre-Service Teachers' Year Long Field Experience*"

Accordingly, be advised that the head of Ministry has granted permission for you to carry out the research at Belvedere and Hillside Teachers' College.

It is hoped that your research will benefit the Ministry. Accordingly, it would be appreciated if you could supply the office of the Permanent Secretary with a final copy of your study, as the findings would be relevant to the Ministry's Strategic Planning Process.

M. J. Chirapa (Ms)
For: PERMANENT SECRETARY

c.c   Mr J. T. Dewah   – Director Tertiary Education Programmes

The Principal   -Belvedere Teachers' College

-Hillside Teachers' College

3B: Clearance Letter – Ministry of Primary and Secondary Education

Zimbabwe

All communications should be addressed to "The Secretary for Primary and Secondary Education"
Telephone: 799914 and 705153
Telegraphic address : "EDUCATION"
Fax: 791923

ZIMBABWE

Reference: C/426/3
Ministry of Primary and
Secondary Education
P.O Box CY 121
Causeway
ZIMBABWE

17 July 2015

Chipo-Makamure
538 Manombe Close
Hellensvale
Borrowdale
Harare

RE: PERMISSION TO CARRY OUT RESEARCH IN HARARE; BULAWAYO METROPOLITAN AND MASHONALAND EAST PROVINCE

Reference is made to your application to carry out a research in the above mentioned provinces on the research title:

"LEARNING TO TEACH SECONDARY SCHOOL MATHEMATICS FROM PRACTICE: AN EXPLORATION OF THE ZIMBABWEAN PRE-SERVICE TEACHERS' YEAR LONG FIELD EXPERIENCES"

Permission is hereby granted. However, you are required to liaise with the Provincial Education Directors Harare, Bulawayo Metropolitan and Mashonaland East, who are responsible for the provinces which you want to involve in your research.

You are required to provide a copy of your final report to the Secretary for Primary and Secondary Education by December 2016.

E. Chinyowa
Acting Director: Policy Planning, Research and Development
For: **SECRETARY FOR PRIMARY AND SECONDARY EDUCATION**
cc: PEDS – Bulawayo; Harare Metropolitan and Mashonaland Central Province

3C: Clearance Letter – Ministry of Education Harare Province

All communications should
be addressed to
"THE PROVINCIAL
EDUCATION DIRECTOR"

Telephone : 792671-9
Fax : 796125/792548
E-mail
moeschre@yahoo.com

ZIMBABWE

REF: G/42/1
Ministry of Education,
Sport and Culture
Harare Provincial Education
Office
P. O. Box CY 1343
Causeway
Zimbabwe

Mrs Chipo. Makonumire
535 Mane-le Close
Hatcliffe

RE: PERMISSION TO CARRY OUT RESEARCH IN SOME SELECTED SCHOOLS

Mbare-Hatfield District, Epworth/Mabvuku/Tafara District, Northern Central District, HighGlen District, Glen View-Mufakose District, Chitungwiza District, Warren Park-Mabelreign District, "Learning To Teach Secondary School Mathematics from Practice: An Exploration of the Zimbabwean Pre-Service Teachers' long Field Experiences"

Reference is made to your letter dated .... 17 July 2015

Please be advised that the Provincial Education Director grants you authority to carry out your research on the above topic. You are required to supply Provincial Office with a copy of your research findings.

CHIRAPA E.

For: Provincial Education Director
Harare Metropolitan Province

Please assist

5

3D: Clearance Letter – Ministry of Education Bulawayo Metropolitan

all communications should be addressed to
"The Provincial Education Director"
Telephone: 09-69511
Telegraphic: "SCHOLASTIC"
Telex: 50531 MPSEMN ZW
Fax: 09-77027

ZIMBABWE

Ministry of Primary and Secondary Education
Bulawayo Metropolitan Province
P O Box 555
Bulawayo
Zimbabwe

31 August 2015

Chipo. Makamure
Harare

RE: PERMISSION TO CARRY OUT RESEARCH: ON LEARNING TO TEACH
SECONDARY SCHOOL MATHEMATICS FROM PRACTICE : AN
EXPLORATION OF THE ZIMBABWEAN PRE-SERVICE TEACHERS'
YEAR LONG FIELD EXPERIENCES

With reference to your application to carry out a research on the above
mentioned topic in the Education Institutions under the jurisdiction of the
Bulawayo Province permission is hereby granted. However, you should liaise
with the Head of the Institution/School for clearance before carrying out your
research.

It will also be appreciated if you could supply the Bulawayo Province with a
final copy of your research which may contain information useful to the
development of education in the province.

3 1 AUG 2015

For: PROVINCIAL EDUCATION DIRECTOR
BULAWAYO METROPOLITAN PROVINCE

3E: Clearance Letter – Ministry of Education Mashonaland East

Reference: P|.MAKAMURE.C

E. C. No.: 0862316Z

All communications should be addressed to
"The Provincial Education Director Mashonaland East Province"
Telephone: 0279-24811/4 and 24792
Telex :
Fax: 079-24791

Ministry of Primary & Secondary Education
Mashonaland East Province
P.O. Box 752
Marondera
Zimbabwe

ZIMBABWE

[stamp: MINISTRY OF EDUCATION AND CULTURE ... EDUCATION OFFICER ... 26 AUG 2015 (ADMINISTRATION AND SERVICES) MASHONALAND EAST REGION P.O. BOX 752, MARONDERA]

Mr./Mrs./Miss ...... C. MAKAMURE ......
538 MANOMBE CLOSE
HELLENSVALE
BORROWDALE
HARARE

PERMISSION TO CARRY OUT RESEARCH IN SCHOOL FOR EDUCATIONAL PURPOSES: MR/MRS/MISS ...C..MAKAMURE...... E. C. NO. 0862316Z
STUDENT I. D. 2014157503. HEAD/TEACHER AT ...... LECTURER BELVEDERE SCHOOL TEACHERS' COLLEGE .

Reference is made to your minute dated ...... 26 AUGUST   2015 ......
Please be advised that permission has been granted that you carry out research work in our schools. You are accordingly being asked to furnish the Ministry with information about your findings so that we share the knowledge for the benefit of the system as well as our nation at large.

We wish you all the best and hope to hear from you after completing your project work.

....

HUMAN RESOURCES OFFICER – DISCIPLINE
FOR PROVINCIAL EDUCATION DIRECTOR
MASHONALAND EAST PROVINCE
/mm

APPENDIX 4: INVITATION LETTERS TO PARTICIPATE IN THE RESEARCH

4A: Invitation Letter to Pre-service Teachers to participate in questionnaires

538 Manombe Close

Helensvale

Borrowdale

Harare

Dear Participant (Pre-service teachers)

INVITATION TO PARTICIPATE IN QUESTIONNAIRES ON "LEARNING TO TEACH" RESEARCH STUDY

I hereby invite you to participate in my study on "learning to teach" through practice. My name is Chipo Makamure, and I am presently studying for a PhD degree with the University of the Free State. I am also Head of Department Natural Sciences, at Belvedere Technical Teachers' College. As part of my Doctoral programme, I am required to conduct research on an aspect of interest with a view to making a contribution to our knowledge and understanding of the issue under study. The title of my thesis is:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

The purpose of the study is to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. The study, therefore, focuses on how pre-service teachers develop their mathematical knowledge of teaching through practice during the process of learning to teach. An understanding of how the process of "learning to teach" develops can create an opportunity for teacher education curriculum developers to design new curricular that are personally relevant to pre-service teachers' needs.

The study will involve pre-service teachers completing questionnaires before and

during teaching practice. You may also be selected to participate in follow-up interviews at a time that is convenient to you. Semi-structured Interviews with selected teacher educators (both school and college based) will also be carried out. Both the interviews and questionnaire completion are expected to last not more than an hour. Please take note that the interviews may be audio taped if need be.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the college and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they so wish.

I hope and believe that your contribution is significantly important to this study.
If you need any further information and/or have suggestions, please do not hesitate to contact me and/or my research supervisor:

 Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522.

Thank you for your kind consideration of my request.

Yours sincerely

Chipo Makamure

Cell: +263 772 432 465 (E-mail: makamburec@gmail.com)

If you agree to participate in the research study entitled:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

Please complete the attached consent form

- *I hereby give free and informed consent to participate in the abovementioned research study.*
- *I understand what the study is about, why I have been approached to participate.*
- *I understand what the potential benefits and risks are.*
- *I give the researcher permission to make use of the information collected from my participation, for research purposes only.*

Participant's Signature: _____ Date: _____

Researcher's Signature: _____ Date: _____

4B: Invitation Letter to Pre-service Teachers to participate in interviews

538 Manombe Close

Helensvale

Borrowdale

Harare

Dear Participant (Pre-service teachers)

INVITATION TO PARTICIPATE IN FOCUS GROUP INTERVIEWS ON "LEARNING TO TEACH" RESEARCH STUDY

I hereby invite you to participate in my study on "learning to teach" through practice. My name is Chipo Makamure, and I am presently studying for a PhD degree with the University of the Free State. I am also Head of Department Natural Sciences, at Belvedere Technical Teachers' College. As part of my Doctoral programme, I am required to conduct research on an aspect of interest with a view to making a contribution to our knowledge and understanding of the issue under study. The title of my thesis is:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

The purpose of the study is to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. The study, therefore, focuses on how pre-service teachers develop their mathematical knowledge of teaching through practice during the process of learning to teach. An understanding of how the process of "learning to teach" develops can create an opportunity for teacher education curriculum developers to design new curricular that are personally relevant to pre-service teachers' needs.

The study will involve pre-service teachers completing questionnaires before and during teaching practice. You may also be selected to participate in follow-up

interviews at a time that is convenient to you. Semi-structured Interviews with selected teacher educators (both school and college based) will also be carried out. Both the interviews and questionnaire completion are expected to last not more than an hour. Please take note that the interviews may be audio taped if need be.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the college and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they so wish.

I hope and believe that your contribution is significantly important to this study.
If you need any further information and/or have suggestions, please do not hesitate to contact me and/or my research supervisor:

 Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522.

Thank you for your kind consideration of my request.

Yours sincerely

Chipo Makamure

Cell: +263 772 432 465 (E-mail: makamburec@gmail.com)

If you agree to participate in the research study entitled:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

Please complete the attached consent form

- *I hereby give free and informed consent to participate in the abovementioned research study.*
- *I understand what the study is about, why I have been approached to participate.*
- *I understand what the potential benefits and risks are.*
- *I give the researcher permission to make use of the information collected from my participation, for research purposes only.*

Participant's Signature: _____ Date: _____

Researcher's Signature: _____ Date: _____

4C: Invitation Letter to college Lecturers to participate in interviews

538 Manombe Close

Helensvale

Borrowdale

Harare

Dear Participant /Lecturers

INVITATION TO PARTICIPATE IN INTERVIEWS ON "LEARNING TO TEACH" RESEARCH STUDY

I hereby invite you to participate in my study on "learning to teach" through practice. My name is Chipo Makamure, and I am presently studying for a PhD degree with the University of the Free State. I am also Head of Department Natural Sciences, at Belvedere Technical Teachers' College. As part of my Doctoral programme, I am required to conduct research on an aspect of interest with a view to making a contribution to our knowledge and understanding of the issue under study. The title of my thesis is:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

The purpose of the study is to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. The study, therefore, focuses on how pre-service teachers develop their mathematical knowledge of teaching through practice during the process of learning to teach. An understanding of how the process of "learning to teach" develops can create an opportunity for teacher education curriculum developers to design new curricular that are personally relevant to pre-service teachers' needs.

The study will involve pre-service teachers completing questionnaires before and

during teaching practice. They may also be selected to participate in follow-up interviews at a time that is convenient to them. Semi-structured Interviews with selected teacher educators (both school and college based) will also be carried out. Both the interviews and questionnaire completion are expected to last not more than an hour. Please take note that the interviews may be audio taped if need be.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the college and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they so wish.

Upon the completion of the study, I undertake to provide you with a copy of the research report and to share my findings with you.

I hope and believe that your contribution is significantly important to this study. If you need any further information and/or have suggestions, please do not hesitate to contact me and/or my research supervisor:

 Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522.

Thank you for your kind consideration of my request.

Yours sincerely

Chipo Makamure

Cell: +263 772 432 465 (E-mail: makamburec@gmail.com)

If you agree to participate in the research study entitled:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

Please complete the attached consent form

- *I hereby give free and informed consent to participate in the abovementioned research study.*
- *I understand what the study is about, why I have been approached to participate.*
- *I understand what the potential benefits and risks are.*
- *I give the researcher permission to make use of the information collected from my participation, for research purposes only.*

Participant's Signature: _____ Date: _____

Researcher's Signature: _____ Date: _____

4D: Invitation Letter to Mentors to participate in questionnaires

538 Manombe Close

Helensvale

Borrowdale

Harare

Dear Participant /Mentor

INVITATION TO PARTICIPATE IN QUESTIONNAIRES ON "LEARNING TO TEACH" RESEARCH STUDY

I hereby invite you to participate in my study on "learning to teach" through practice. My name is Chipo Makamure, and I am presently studying for a PhD degree with the University of the Free State. I am also Head of Department Natural Sciences, at Belvedere Technical Teachers' College. As part of my Doctoral programme, I am required to conduct research on an aspect of interest with a view to making a contribution to our knowledge and understanding of the issue under study. The title of my thesis is:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

The purpose of the study is to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. The study, therefore, focuses on how pre-service teachers develop their mathematical knowledge of teaching through practice during the process of learning to teach. An understanding of how the process of "learning to teach" develops can create an opportunity for teacher education curriculum developers to design new curricular that are personally relevant to pre-service teachers' needs.

The study will involve pre-service teachers completing questionnaires before and during teaching practice. They may also be selected to participate in follow-up

interviews at a time that is convenient to them. Semi-structured Interviews with selected teacher educators (both school and college based) will also be carried out. Both the interviews and questionnaire completion are expected to last not more than an hour. Please take note that the interviews may be audio taped if need be.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the college and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they so wish.

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 Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522.

Thank you for your kind consideration of my request.

Yours sincerely

Chipo Makamure

Cell: +263 772 432 465 (E-mail: makamburec@gmail.com)

If you agree to participate in the research study entitled:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

Please complete the attached consent form

- *I hereby give free and informed consent to participate in the abovementioned research study.*
- *I understand what the study is about, why I have been approached to participate.*
- *I understand what the potential benefits and risks are.*
- *I give the researcher permission to make use of the information collected from my participation, for research purposes only.*

Participant's Signature: _____ Date: _____

Researcher's Signature: _____ Date: _____

4E: Invitation Letter to Mentors to participate in interviews

538 Manombe Close

Helensvale

Borrowdale

Harare

Dear Participant

INVITATION TO PARTICIPATE IN INTERVIEWS ON "LEARNING TO TEACH" RESEARCH STUDY

I hereby invite you to participate in my study on "learning to teach" through practice. My name is Chipo Makamure, and I am presently studying for a PhD degree with the University of the Free State. I am also Head of Department Natural Sciences, at Belvedere Technical Teachers' College. As part of my Doctoral programme, I am required to conduct research on an aspect of interest with a view to making a contribution to our knowledge and understanding of the issue under study. The title of my thesis is:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

The purpose of the study is to explore the significance and contribution of teaching practice to teacher knowledge and expertise, as described by the concept of "learning to teach", for secondary school mathematics in Zimbabwe. The study, therefore, focuses on how pre-service teachers develop their mathematical knowledge of teaching through practice during the process of learning to teach. An understanding of how the process of "learning to teach" develops can create an opportunity for teacher education curriculum developers to design new curricular that are personally relevant to pre-service teachers' needs.

The study will involve pre-service teachers completing questionnaires before and during teaching practice. They may also be selected to participate in follow-up

interviews at a time that is convenient to them. Semi-structured Interviews with selected teacher educators (both school and college based) will also be carried out. Both the interviews and questionnaire completion are expected to last not more than an hour. Please take note that the interviews may be audio taped if need be.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the college and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they so wish.

Upon the completion of the study, I undertake to provide you with a copy of the research report and to share my findings with you.

I hope and believe that your contribution is significantly important to this study. If you need any further information and/or have suggestions, please do not hesitate to contact me and/or my research supervisor:

 Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522.

Thank you for your kind consideration of my request.

Yours sincerely

Chipo Makamure

Cell: +263 772 432 465 (E-mail: makamburec@gmail.com)

If you agree to participate in the research study entitled:

Learning to teach secondary school mathematics from practice: an exploration of the Zimbabwean pre-service teachers' year-long field experiences.

Please complete the attached consent form

- *I hereby give free and informed consent to participate in the abovementioned research study.*
- *I understand what the study is about, why I have been approached to participate.*
- *I understand what the potential benefits and risks are.*
- *I give the researcher permission to make use of the information collected from my participation, for research purposes only.*

Participant's Signature: _____ Date: _____

Researcher's Signature: _____ Date: _____

APPENDIX 5:   RESEARCH INSTRUMENTS

5A: Questionnaire for pre-service teachers (before teaching practice)

SECTION A

Tick the appropriate box

Demographic Information:

1. Your email address: ……………. [   ]
2. Gender:

    Female   …………………… [   ]

    Male…………………………… [   ]

3. Age Range
    18 – 20………………………… [   ]
    21 – 25   ………………… [   ]
    26 – 30…………………………. [   ]
    31 +   ………………………… [   ]

4. Type of High School attended

    Rural Day School……………… [   ]
    Urban –government school…… [   ]
    Urban – Private school………… [   ]
    Mission school………………… [   ]

5. Institution:
    Belvedere……………………… [   ]
    Hillside   …………………… [   ]

6. Teaching Experience before College:

None…………………………… ☐

1 - 3 years …………………… ☐

Over 3 years…………………… ☐

SECTION B

Respond by putting an x in the appropriate box. The meanings of the abbreviated responses are as follows: **S.A**-strongly agree; **A**-agree; **N**-neutral; **D**-disagree &**S.D**-strongly disagree.

LEARNING TO TEACH THROUGH PRACTICE

LEARNING TO TEACH THROUGH PRACTICE Indicator	S.A	A	N	D	S.D
Expectations about teaching					
7. I can organise a lesson to boost student learning					
8. I know how to manage my classroom during lessons					
9. I know how to deal with students' misconceptions and understandings					
10. I can adjust my way of teaching on the basis of what students have grasped					
11. I will be able to adjust my styles of teaching to suit various learners					
12. I can choose good teaching strategies to direct students learning in Mathematics.					
13. I can select appropriate teaching resources that improve my teaching strategies for a mathematics lesson					
14. Knowing about different approaches means I can use them for					

	teaching					
15.	Using a variety of approaches to teach a mathematical concept may confuse students					
16.	I will be able to utilize the skills and techniques gained in college during teaching practice					
17.	I will be able to relate very well with the students during teaching practice					
18.	The teacher must accept students' ideas and propositions					
19.	I can motivate the students who lack the desire to do mathematics					
20.	I can assess student learning in various ways					
21.	Teaching is what I expected in life					
22.	A mentor is an expert in teaching mathematics					
23.	Mentors create and maintain a welcoming socio-professional context for pre-service teachers					
24.	Mentors are always motivated and enthusiastic about teaching and consistent in all stages of teaching					
25.	I hope to learn a lot from my mentor					
Beliefs about teaching						
26.	Mathematics is a difficult subject					
27	Mathematics requires a smart teacher to promote student					

	achievement					
28.	Mathematics is more suitable for boys than girls					
29.	Boys find mathematics to be easier than girls no matter how good the teacher is					
30.	Mathematics teaching at "O" level is more effective if a teacher has more mathematics content knowledge (e.g a degree in mathematics)					
31.	Knowing mathematics and the ability to teach it are independent of each other					
32.	Knowing mathematics involves the ability to remember formulas and procedures					
Pre-service teachers' nature of knowledge in preparation for teaching practice						
33.	I have adequate knowledge about the mathematics content I will teach					
34.	I can think mathematically					
35.	I have different ways of improving my understanding of mathematics					
36.	"A" level mathematics content is enough for a teacher to teach up to "O" level					
37.	The mathematics education I was taught in college has					

	enabled me to think deeply about the mathematics I will teach					
38.	The mathematics education I was taught in college has enabled me to become confident that I will be a good teacher					
	Knowledge about Learners					
39.	I am very fair and objective to learners including all learners in my lessons					
40.	I will be able to respect the socio-cultural diversities of learners (religion, gender, ethnic, language etc)					
41.	I know how to deal with stressed students in the classroom					
42.	I know how to care and reinforce the well-being of all the students					

SECTION C

43. Why did you choose to become a teacher?

....

....

....

44. What are your plans for promoting and perpetuating your professional growth?

....

....

....

45. Which topics did you cover in your first year at college before teaching practice?

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....
....

46. How do you expect these topics to help you during teaching practice?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………

47. What are some of the activities that you would like to do during teaching practice to teach mathematics effectively?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

48.   What needs and/or expectations do you have of the school administration (The Head, Deputy Head and HOD)?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………

49. How do you expect to deal with learners who misbehave during lessons?

....
....
....

THANK YOU!!

5B: **Questionnaire for pre-service teachers (during TP)**

SECTION A

Tick the appropriate box

Demographic Information:

1. Your email address: …………… [   ]
2. Gender:

   Female………………………… [   ]

   Male……………………………… [   ]

3. Age Range
   18 – 20………………………… [   ]
   21 – 25………………………… [   ]
   26 – 30………………………… [   ]
   31 +   ………………………… [   ]

4. School of Practice

   Rural Day School……………… [   ]
   Urban –government school…… [   ]
   Urban – Private school………… [   ]
   Mission school………………… [   ]

5. Institution:
   Belvedere……………………… [   ]
   Hillside………………………… [   ]

6. Level being taught
   (If you are teaching more than one levels, tick both)

Form 1…………………………… ☐

Form 2 ………………………… ☐

Form 3………………………… ☐

Form 4………………………… ☐

SECTION B

Respond by putting an x in the appropriate box. The meanings of the abbreviated responses are as follows: **S.A**-strongly agree; **A**-agree; **N**-neutral; **D**-disagree &**S.D**-strongly disagree.

LEARNING TO TEACH THROUGH PRACTICE

	LEARNING TO TEACH THROUGH PRACTICE Indicator	S.A	A	N	D	S.D
	Experiences during teaching practice					
7.	The college has done well to prepare me for the classroom					
8.	I am confident to teach mathematics					
9.	My classroom management skills are quite appropriate					
10.	I have an understanding of how students learn mathematics					
11.	I can apply different teaching approaches during lessons at the appropriate time					
12.	Using a variety of approaches to teach a mathematical concept may confuse students					
13	Knowing about different approaches means I can use them for teaching					
14.	I use the text book quite often during my lessons					
15.	I can select appropriate teaching resources that enhance my					

	teaching approaches for a mathematics lesson					
16.	Teaching practice has given me an opportunity to experiment with teaching approaches covered theoretically at college					
17.	I got a lot of insight on how students learn mathematics during teaching practice					
18.	It is quite easy to utilize the skills and techniques gained in college during teaching practice					
19	I can motivate students who lack the desire to do mathematics					
20.	There is a sound relationship between myself and my students					
21.	I am concerned about my ability to meet the needs of slow learners					
22.	I will be able to adjust my styles of teaching to suit various learners					
23.	I give remedial work every time students have difficulties in grasping a concept					
24.	I respect and accept students' thoughts and suggestions					
25.	I allow students to use their own methods of learning					
26.	I can assess and evaluate my students' performance in the classroom					
27.	The school is doing enough to assist me during teaching practice					
28.	The college is doing enough to assist me during teaching practice					
29.	Teaching is what I expected in life					

30.	My expectations before teaching practice match my experiences during teaching practice				
Experiences with Mentors					
31.	A mentor is an expert in teaching mathematics				
32.	Mentors are always motivated and enthusiastic about teaching and consistent in all stages of teaching				
33.	My mentor helps me to plan for the lessons				
34.	My mentor helps me to decide on the media to use for developing concepts				
35.	My mentor helps me to decide on which teaching approaches to use for my lessons				
36.	My mentor did let me sit in a lesson she was teaching during my teaching practice				
37	My mentor demonstrated some of the teaching approaches before asking me to teach a lesson				
38.	My mentor coached me on how to teach				
39.	My mentor regularly sits in on lessons that I teach				
40.	My mentor allows me to use the teaching methods I feel will be useful to develop the concepts				
41.	My school-based mentors provide constructive feedback and professional support that develops my teaching competency				

No.	Statement					
42.	My College-based mentors provide constructive feedback and professional support that develops my teaching competency					
43.	My school-based mathematics mentor appropriately models blending content and teaching strategies in his/her teaching					
44	My College-based mathematics mentor appropriately models blending content and teaching strategies in his/her teaching					
	Beliefs and background about teaching					
45.	Mathematics is a difficult subject					
46.	Mathematics requires a smart teacher to promote student achievement					
47.	Mathematics is more suitable for boys than girls					
48.	Boys find mathematics to be easier than girls no matter how good the teacher is					
49.	Mathematics teaching at "O" level is more effective if a teacher has more mathematics content knowledge (e.g a degree in mathematics)					
50.	Knowing mathematics and the ability to teach it cannot be separated					
51.	Knowing mathematics involves the ability to remember formulas and procedures					
52.	My beliefs before teaching practice match my experiences					

	during teaching practice					
53.	Teaching practice has changed my beliefs about mathematics teaching					
Pre-service teachers' nature of knowledge during teaching practice						
54.	The course work material covered enough content that helped me to teach well during teaching practice					
55.	I have adequate knowledge about the mathematics content I teach					
56.	I can think mathematically					
57.	I have different ways of improving my understanding of mathematics					
58.	"A" level mathematics content is enough for a teacher to teach up to "O" level					
59.	The mathematics education covered in the course prepared me to teach mathematics with confidence					
60.	The mathematics content in the classes that I teach is difficult					
61.	After qualifying as a teacher, I will prefer to teach mathematics at junior level (Forms 1 & 2)					
62.	After qualifying as a teacher, I will prefer to teach mathematics at "O" level (Forms 3 & 4)					
63.	I gained a lot of knowledge about teaching during teaching					

	practice					
	Knowledge about Learners					
64.	I am fair and objective to learners by including all learners in my lessons					
65.	I respect the socio-cultural diversities of learners (religion, gender, ethnic, language etc)					
66.	I know how to deal with stressed students in the classroom					
67.	I know how to care and reinforce the well-being of my students					

SECTION C

68. How do you describe the mentor's behaviour towards you during teaching practice?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

69. How do you describe the college supervisors' behaviour towards you during their field visits?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

70. What do you consider to be your strengths during teaching practice?

……………………………………………………………………………………………

………
………

71. How do you use your strengths in your teaching?

………
………
………

72. What do you consider to be your weaknesses and limitations in your teaching? How do you expect to overcome them?

………
………
……

73. What current trends in the school please and/or displease you?

………
………
………

74. What current trends in the ministry of Education please and/or displease you?..
....
....

75. Is there anything you wish you had studied before you started teaching practice?

………
………
………

THANK YOU!!

5C: Focus group interviews for pre-service teachers

Name and Background

1. What prompted you to become a teacher?
2. How did you experience the job of teaching during the teaching practice? Is it easy or difficult? Give reasons for your response. [Probe: listen for conditions in school; preparation at college or lack thereof, discipline issues; subject or curriculum related issues].
3. Talk to me about your teaching experiences you have had before coming to the college, [Probe: for prior experiences of student teaching – focus; duration; learning; mentoring; etc]
4. How has your university education prepared you for this position?
5. How have your experiences about teaching prepared you for this position?

Experiences of teaching during teaching practice

6. What was your view of teaching practice before you started and how has it changed now?
7. What do you consider as the most challenging aspects during teaching practice?
8. Why do you think the aspects mentioned above are challenging?
9. What do you consider as the easiest aspects of teaching practice? Why do you think the aspects are easy?
10. If I visited your classes many times, what is the most common approach or structure of the lesson I am more likely to see? Please give me an example of this structure (approach) using one of the content topics you taught recently.
11. Describe to me how you would motivate a student who does not perform well in mathematics?
12. How would you motivate a learner who simply thinks mathematics is difficult and does not like the subject? Has this happened during your teaching practice? Give me a specific example.

13. If your class consists of students of different levels of ability, how would you teach a topic to the different groups of students in a lesson? Give an example of a topic that you have taught to such a class and how you taught the topic.
14. How do you ensure that students remain working, focused and well behaved after giving them an exercise to do in the classroom? What will you be doing during the time the students will be doing the exercise?
15. What do you consider as your weaknesses during teaching practice with regards to teaching approaches, classroom management and lesson preparation? Give a specific example of a lesson which you could hardly execute because of these weaknesses.
16. What do you consider as your strengths during teaching practice with regards to teaching approaches, classroom management and lesson preparation?
17. What is the most exciting thing that has happened during teaching practice? Why do you think it was exciting and how did it affect your teaching?
18. What has been your most negative teaching experience during teaching practice? How did it happen and why do you think it was negative?

Mentoring practices

19. Did you receive any mentoring during teaching practice? Describe the mentoring practices you experienced during teaching practice giving examples of what exactly happened. Explain to me if the mentoring was effective. What did you learn from that experience?
20. What were some of the challenges you faced with your school based-mentors during teaching practice? How did you handle the challenges?
21. Did you get any guidance from mentors to know the dynamics of the school environment? Who of you think the guidance they received about how to negotiate the school environment was enough? Give me specific examples. Who of you think the guidance was not enough? Give examples.

Educational Experiences

22. What have you learned during teaching practice that will help you in the future?

23. What do you feel you still need to learn/do in order to improve your teaching?
24. To what extent has the school administration (Head of school, Deputy Head and Head of Department) assisted you to be successful in your teaching?
25. To what extent has the college supervisors assisted you to be successful in your teaching? Specify what they actually did for you.
26. What are your perspectives on teaching now after teaching practice? How are they different from the ones you had before you started teaching practice? Give me examples.
27. To what extent do you think your beliefs before teaching practice match your experiences during teaching practice? Give specific examples.
28. To what extent do you think your expectations before teaching practice match your experiences during teaching practice? Give specific examples.
29. Give one piece of advice for upcoming pre-service teachers about teaching practice.

THANK YOU!!

5D: Interviews for college-based Lecturers

	Name and Background	Responses
1.	What is your highest qualification?	
2.	What does the job of mathematics lecturer entail?	
3.	Describe your university experience, giving examples, before you became a mathematics lecturer.	
4.	How has your university experience prepared you for the job of mathematics lecturer?	
5.	What do you think influences your performance in this job?	
6.	Tell me about how you recruit new lecturers in your college. What is the procedure? How are they assessed?	
	Views about Pre-service teachers' nature of knowledge	
7	What kind of pre-service teachers would you recruit for your program, if you were in charge of recruitment?	
8.	Do you participate in curriculum review or curriculum change at the college? Please describe your	

	involvement by way of examples.	
9.	What kind of knowledge would you want your pre-service teachers to possess?	
10.	Talk to me about the existing curriculum for post "A" level pre-service teachers?	
11.	How is your mathematics education program divided? What are the various components? How much time do you devote to each aspect of the course; (pure mathematics, Applied mathematics, Mathematics education, etc)?	
12.	Which topics of the syllabus do you normally want to teach?	
13.	What types of assignments have you given your students this year?	
14.	What kind of pedagogical support is provided for pre-service teachers at your institution? Describe using examples.	
15.	In your view, is the current curriculum adequate to prepare pre-service teachers for teaching practice? [Probe: explain what you mean].	
16.	Before a pre-service teacher goes on teaching practice, is there an assessment that is required regarding the pre-service teacher's pedagogical competence? If yes, explain to me about the kind of assessment that is in place.	

	Views about pre-service teachers' orientation on teaching practice	
17.	Have you supervised practicum students before?	
18.	Do you conduct workshops on teaching practice for pre-service teachers before they leave for teaching practice?	
19.	Do you conduct workshops on teaching practice for lecturers? If so, describe what happens at the workshops; how often and how long do you hold the workshops?	
20.	Are there formal requirements for mentor teachers during pre-service teachers' field placements?	
21.	Do you conduct workshops on teaching practice supervision for school based mentors? If not, how do they come to know what is expected of them?	
22.	To what extent are workshops or other teaching activities about teaching practice skills provided to pre-service teachers?	
	Views about pre-service teachers' experiences	
23.	Based on your assessment of pre-service teachers during teaching practice, what is the level of use of technological equipment in the classrooms to	

	facilitate teaching?	
24.	Talk to me about the level of use of such technological equipment at your college when conducting lessons.	
25.	From your experience as a supervisor, do "A" level grades in mathematics influence the pre-service teacher's ability to teach the subject? Explain why you think so.	
26.	When supervising pre-service teachers on teaching practice, what attributes of the pre-service teachers do you exactly look for?	
27.	What is your specific role in contributing to the current professional learning during teaching practice?	
28.	From your own assessment, do the pre-service teachers enjoy teaching mathematics during teaching practice? Why do you say so? If they do not, how do you expect to curtail the problems?	
29.	What challenges do you think pre-service teachers experience during teaching practice? How can they be addressed?	
30.	What problems do you face with pre-service teachers on teaching practice? [listen and probe for: problems regarding their lesson preparation, their way of teaching, discipline, etc] How are these addressed?	

5E: Questionnaire for School-based Mentors

SECTION A

Tick the appropriate box

1. Your email address: ………….. [   ]
2. Gender:

   Female………………………… [   ]

   Male…………………………… [   ]

3. Age Range
   22 – 30……………………… [   ]
   31 – 40……………………… [   ]
   41– 50……………………… [   ]
   50 +………………………… [   ]

4. School of Practice
   Rural Day School……………… [   ]
   Urban –government school…… [   ]
   Urban – Private school………… [   ]
   Mission school………………… [   ]

5. Teaching Qualification:
   BED………………………… [   ]
   Teaching Degree & Grad CE…. [   ]
   Degree without Grad CE………. [   ]
   Diploma/Certificate in Education [   ]
   Any other (state)……………… [   ]

6. Teaching experience
   0-3 years………………………… [   ]
   4-10 years ……………………… [   ]
   11-20……………………………… [   ]

Over 20 years…………………… ☐

7. Mentoring Experience:
   0-3 years………………………. ☐
   4-7 years ……………………… ☐
   8-10………………………………. ☐
   Over 10 years…………………. ☐

SECTION B

Respond by putting an x in the appropriate box. The meanings of the abbreviated responses are as follows: **S.A**-strongly agree; **A**-agree; **N**-neutral; **D**-disagree & **S.D**-strongly disagree.

LEARNING TO TEACH THROUGH PRACTICE Indicator	S.A	A	N	D	S.D
Mentoring practices					
8. I act as a role model to the mentee in my own teaching					
9. I encourage the mentee's own initiatives in the classroom					
10. I provide my mentees with useful feedback and support that develop their teaching competence					
11. I give my mentees enough guidance regarding the transition phase of getting to know the dynamics of the school environment					
12. There is a sound relationship between myself and my mentee					
13. I have received adequate training to be an effective mentor					
14. I gained my skills and expertise in mentoring through experience					
15. My mentee provides useful teaching assistance to me as the mentor					
Mentors' views on pre-service teachers' nature of knowledge and understanding about teaching					
16. The college has done enough to prepare pre-service teachers					

	for teaching practice					
17.	My mentee knows the content he/she teaches					
18.	My mentee's classroom management is very satisfactory					
19.	Field experience courses offered in teachers' colleges for pre-service teachers need to be enhanced in terms of peer teaching					
20.	My mentee often has problems of explaining concepts explicitly to the students					
21.	My mentee can conceptualise and analyse situations to solve problems					
Mentors' views on educational practices and skills of pre-service teachers						
22.	My mentee can structure lessons to promote students' learning					
23.	My mentee can adjust the way he/she teaches based on what students understand or do not understand					
24.	My mentee knows how to develop schemes of work and lesson plans.					
25.	My mentee can select and adapt effective teaching strategies and learning activities					
26.	My mentee is capable of identifying and attending to learners' needs					

27.	My mentee is capable of setting, marking and grading students' achievement using a variety of assessment skills					
28.	My mentee can manage time effectively					
29.	My mentee critically reflects on his/her work to improve practice					
30	My mentee can create a conducive learning environment that encourages learning in his/her lessons					
31.	My mentee is able to adapt to change					
	Mentor relationship with mentee					
32.	My mentee shares and asks for teaching ideas from me					
33.	My mentee informs about the content of the weekly tasks					
34.	My mentee listens and considers the mentor's advice					
35.	My mentee is very open to changes and acts flexibly					
36.	My mentee's behaviour is often a burden to the school					

SECTION C

37. How do you assist and supervise your mentee during teaching practice?

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…

38. What problems do you face with pre-service teachers during teaching practice? How can these problems be addressed?

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

…

39. What do you like about pre-service teachers during teaching practice?

………………………………………………………………………………………

………………………………………………………………………………………

…………………………………………………………………………

THANK YOU!!

5F: Focus group interviews for mentors (school based).

Mentoring practices

1. What prompted you to become a mentor?
2. How do you see the mentoring practice and its significance? Describe the mentoring practices you do to pre-service teachers during teaching practice.
3. What do you feel you need to learn and/or do in order to improve your mentoring skills?
4. Are there any formal requirements that you need in order to be selected or recruited as a mentor?
5. What are your strengths in mentoring pre-service teachers on teaching practice? Give examples.
6. How do you challenge pre-service teachers? [probe: especially those who are struggling with teaching practice]
7. How often do you send a pre-service teacher to teach your class on his/her own, without your presence?

Relationship with mentees

8. What problems did you face with pre-service teachers during teaching practice? How did you address the problems?
9. How do you explain your relationship with your mentee?

Nature of knowledge

10. From your own assessment, what kind of knowledge are the pre-service teachers strong in?

Educational practices

11. What are the major challenges and limitations that pre-service teachers face during teaching practice? Give examples and how you sought solution to the problems.
12. What are the major successes that pre-service teachers experience during teaching practice? Specify examples.

13. How do you react to a situation where a student teacher that you mentor fails teaching practice – How do you explain such a situation? Has it ever occurred? Give me an example.

THANK YOU!!

APPENDIX 6:   EDUCATIONAL DOCUMENTS REVIEWED

6A: A Summary of the Colleges and School Syllabi reviewed

College (a) SYLLABUS Topics	College (b) SYLLABUS Topics	SCHOOL SYLLABUS (4008/4028) Topics	TEXT BOOKS USED IN SCHOOLS
A: PURE MATHEMATICS **1. Calculus and analytic Geometry** -Circular and hyperbolic functions -Sequences -Coordinate geometry -Continuity & smoothness **Linear Mathematics:** -Motivational material for matrices & linear **Algebra,** e.g., ODEs, -Theory of matrices, Determinants and Linear Algebra, e.g. systems of matrices -Complex numbers and polynomials **Mathematical Structures & Discourse** -Sets & Relations -Logic	**A: PURE MATHEMATICS** **1. Calculus and analytic Geometry** - complex numbers -differential and integral calculus -plane analytic geometry -circular and hyperbolic functions -series -differential equations **-2. Algebra** **-** basic algebra -Boolean algebra - relations and operations -linear programming -matrices and systems of linear equations -vectors in 2-space and 3-space - groups	**A: NUMBERS** **-**Number Concepts & Operations -Directed Numbers, fractions & percentages -Factors & multiples -Limits of accuracy & Approximation -Number bases -Ratio, rates & proportion **B: GEOMETRIC CONCEPTS** -Angles -Bearings -Polygons -Construction & Loci -Symmetry **-Measures & Mensuration** **-transformations** **C: ALGEBRAIC CONCEPTS** -Change of subject -Expansion -Indices	**New General Mathematics** **Books 1 to 4**

-Operations and structures		-Equations -Logarithms -Inequalities -Linear Programming **-Sets** -Definition & Notation **vectors & matrices**	
B: STATISTICS & PROBABILITY -Introduction to statistics -Frequency distributions -Probability, e.g. permutations & combinations -Probability Distributions -Particular discrete & continuous distributions -Sampling & estimation theory -Hypothesis testing -The Chi-square distribution -Bivariate Analysis	**B: APPLIED MATHEMATICS** **1. Statistics and probability theory** -introduction to statistics -descriptive statistics. -probability -probability distribution -some particular discrete distribution -some particular continuous distributions -sampling distributions and estimation theory -hypothesis testing -bivariate analysis -time series	**D: STATISTICS & PROBABILITY** -Data representation -measures of central tendency -Experimental & Theoretical probability	**New General Mathematics** **Books 1 to 4**
C. MECHANICS -Forces & Equilibrium -Kinematics of motion	**2. MECHANICS** **-**kinematics **-**forces and equilibrium -newton's laws of motion	**G: Graphs & Variation** -Coordinates – travel graphs -Variation	**New General Mathematics** **Books 1 to 4**

-Newton's law -Work Power & energy -Projectiles -Momentum & Impulse	-work, power, energy and momentum -motion in a plane -circular motion and simple harmonic motion	-Functional graphs	
MATHEMATICS EDUCATION -Motivation techniques -Strategies of teaching -History of Mathematics -New trends in Maths educ, e.g. gender & ICT -assessment -Formulation of objectives, lesson planning, scheming -Records of work Teaching mixed ability classes.	**3. MATHEMATICS EDUCATION** -instruction -teaching and learning -planning for teaching and learning -assessment and evaluation -strategies of teaching	**D:CONSUMER ARITHMETIC** **E: TRIGONOMETRY** -Pythagoras & Trig Ratios	**New General Mathematics** **Books 1 to 4**

6B: Colleges Schemes of Work

HILLSIDE TEACHERS' COLLEGE

MATHEMATICS DEPARTMENT

TIME TABLE

TIME	MONDAY AL1	AL2/OL3	TUESDAY AL1	AL2/OL3	WEDNESDAY AL1	AL2/OL3	THURSDAY AL1	AL2/OL3	FRIDAY AL1	AL2/OL3
7.45-8.00	ASSEMBLY									
8.00-9.30		MATHS		MED			MATHS			
9.30-11.00	MATHS		MATHS			MATHS				MATHS
11.00-11.30	B		R		E		A		K	
11.30-13.00	MED			ICT PRAC		LIB&RES STAFF DEV	ICT PRAC			
13.00-14.00	L		U		N		C		H	
14.00-15.30		MATHS	CHOIR/PASTORAL		MED			MED	MATHS	
15.30-16.30	CYCLES	CYCLES	RESEARCH		CYCLES	CYCLES	CYCLES	CYCLES	COMM OUTREACH	CYCLES

(Friday: MATHS / PROJECTS)

6C Colleges Schemes of Work

BELVEDERE TECHNICAL TEACHERS' COLLEGE

MATHEMATICS SECTION

TERM 2 2015 TIME TABLE - <u>AMENDED</u>
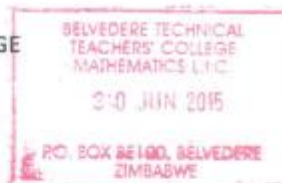
TIME & DAY⇒ ⇓	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
0800-0900	DE1	DE3	ASSEMBLY	DE1; DE2;DE3	DE1,DE2
0915-1015	DE1	DE3	DE1; DE2	DE1; DE2;DE3	DE1,DE2
1015-1045	BREAK	BREAK	BREAK	BREAK	BREAK
1045-1145	DE2,DE3	DE1,2-ED	DE1; DE2	DE3-ED	DE3-ED
1200-1300	DE2,DE3	DE1,2-ED	DE1; DE2	PRINCIPAL HR	DE3-ED
1300-1400	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1400-1500	DE3-ED	DE3	DE3	DE1-ED; DE2-ED	
1515-1615	DE3-ED	DE3	SPORTS	DE1-ED; DE2-ED	

KEY: DE1-ED MEANS DE1 IS DOING MATHS EDUCATION;

DE1 MEANS DE1 IS DOING MATHS CONTENT.
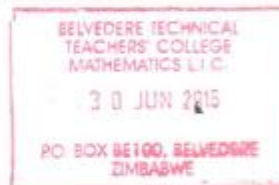
ROOMS: DE1 POST 'O'- B5

DE3------------ B6

APPENDIX 7: STATISTICAL INFORMATION

7A Results for Table 4.8

Teaching Experience * I know how to manage my classroom during lessons

Crosstab

Count

		I know how to manage my classroom during lessons				Total
		Disagree	Neutral	Agree	Strongly Agree	
Teaching Experience	None	4	25	33	9	71
	1 - 3 years	0	4	24	15	43
	Over 3 years	0	0	2	2	4
Total		4	29	59	26	118

Percentages Agreeable:

0 years experience : $(33 + 9)/71 = 59.15\%$

1 – 3 years experience $(24 + 15)/43 = 90.7\%$

Over 3 years: $4/4 = 100\%$

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	18.911[a]	6	.004
Likelihood Ratio	21.841	6	.001
N of Valid Cases	118		

7B   Factor Analysis For Table 4.7

	Total Variance Explained								
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.962	20.852	20.852	3.962	20.852	20.852	2.471	13.004	13.004
2	2.092	11.011	31.863	2.092	11.011	31.863	2.233	11.752	24.756
3	1.538	8.097	39.960	1.538	8.097	39.960	2.166	11.402	36.159
4	1.407	7.405	47.365	1.407	7.405	47.365	1.728	9.093	45.251
5	1.292	6.798	54.163	1.292	6.798	54.163	1.507	7.931	53.182
6	1.230	6.472	60.636	1.230	6.472	60.636	1.343	7.067	60.249
7	1.013	5.332	65.968	1.013	5.332	65.968	1.087	5.719	65.968
8	.884	4.650	70.618						
9	.839	4.415	75.033						
10	.740	3.895	78.928						
11	.643	3.382	82.310						
12	.570	3.002	85.312						
13	.526	2.767	88.079						
14	.483	2.542	90.621						
15	.410	2.160	92.781						
16	.393	2.069	94.850						
17	.344	1.812	96.662						
18	.327	1.722	98.384						
19	.307	1.616	100.000						
Extraction Method: Principal Component Analysis.									

7C Factor analysis For Figure 4.1 : Classroom experiences

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.929	20.536	20.536	4.929	20.536	20.536	2.477	10.322	10.322
2	2.031	8.461	28.997	2.031	8.461	28.997	2.024	8.433	18.755
3	1.840	7.668	36.665	1.840	7.668	36.665	1.973	8.219	26.975
4	1.676	6.982	43.647	1.676	6.982	43.647	1.957	8.154	35.128
5	1.521	6.336	49.983	1.521	6.336	49.983	1.945	8.104	43.233
6	1.393	5.806	55.789	1.393	5.806	55.789	1.828	7.616	50.848
7	1.320	5.498	61.287	1.320	5.498	61.287	1.806	7.527	58.375
8	1.028	4.284	65.571	1.028	4.284	65.571	1.386	5.776	64.151
9	1.011	4.214	69.785	1.011	4.214	69.785	1.352	5.634	69.785
10	.924	3.849	73.633						
11	.861	3.589	77.222						
12	.756	3.151	80.373						
13	.689	2.871	83.244						
14	.580	2.417	85.661						
15	.566	2.359	88.019						
16	.533	2.220	90.239						
17	.428	1.783	92.022						
18	.391	1.629	93.651						
19	.341	1.421	95.072						
20	.303	1.261	96.333						
21	.278	1.159	97.492						
22	.222	.925	98.417						
23	.206	.858	99.275						
24	.174	.725	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix^a

	Component								
	1	2	3	4	5	6	7	8	9
The college has prepared me for the classroom	-0.1612	0.7260	0.0158	0.1748	0.1629	0.0553	0.2476	0.1481	0.0115
I am confident to teach mathematics	0.0891	0.0479	0.2842	0.0371	0.1531	0.1063	0.6088	0.1534	-0.1798
My classroom management skills are quite appropriate	0.1063	0.0179	0.6858	0.2061	0.3465	-0.0025	0.2431	0.1007	-0.1179
I have an understanding of how students learn mathematics	0.1687	-0.1116	0.6458	0.0160	0.1378	0.2319	0.1068	0.0646	0.3158
I can apply different teaching approaches during lessons at appropriate times	0.0434	0.0231	0.1410	0.7178	0.1221	0.1455	0.1619	-0.0917	-0.2223
Using a variety of approaches may confuse students	-0.3174	0.1002	0.2306	0.0665	0.1303	-0.2704	-0.6508	0.1124	0.0376
Know about different approaches means I can use them for teaching	0.2448	0.4072	-0.1780	0.0894	-0.0038	0.3848	-0.0278	0.4669	-0.0549
I use the text book quite often during my lessons	0.0719	0.1056	0.0907	0.0531	0.1156	0.0814	-0.0194	0.0668	0.8592
I can select appropriate teaching resources that enhance my teaching	0.6996	-0.0269	0.2187	0.0197	-0.1416	-0.0186	0.1338	-0.0169	-0.0275
Teaching practice has given me opportunity to experiment approaches done at college	0.3747	0.3690	0.3803	-0.1957	0.1437	-0.0740	-0.2163	0.3572	-0.2559
I got a lot of insight on how students learn mathematics during TP	0.2871	0.0417	0.2822	0.0930	0.2797	-0.0944	0.0818	0.6569	0.1474
It is quite easy to utilise skills gained in college during TP	0.1052	0.3204	0.0045	0.1301	0.6897	-0.0090	0.0424	0.2143	0.1110
I can motivate students who lack the desire to do mathematics	0.6338	0.0017	-0.0229	0.3316	0.2984	0.2596	0.1157	0.0614	-0.0701

There is a sound relationship between myself and students	0.5927	-0.1429	0.0042	0.0135	0.2893	0.0826	0.2722	0.0596	0.0667
I am concerned about my ability to meet the needs of slow learners	0.6175	0.1060	0.0259	0.1879	0.0257	0.1853	-0.2384	0.1235	0.2401
I will be able to adjust my styles of teaching to suit various learners	0.3523	-0.0456	0.1662	0.7146	-0.1779	-0.0218	-0.0284	0.1839	0.1118
I give remedial work every time students have difficulties	0.0205	0.1552	0.0332	0.7290	0.2110	0.0370	-0.0466	-0.0097	0.2173
I respect and accept students thoughts and suggestions	0.1891	-0.0103	0.1039	0.1258	0.1679	0.7878	0.1459	-0.0686	-0.1215
I allow students to use their own methods of learning	0.0336	0.1417	0.1831	0.0274	0.0683	0.7975	-0.0499	0.0082	0.3372
I can assess and evaluate my students' performance in the classroom	0.0078	0.2570	0.6976	0.2350	-0.3207	0.1448	-0.0077	-0.0304	0.0712
The school is doing enough to assist me during TP	0.4576	0.3030	0.0296	0.0989	0.2878	0.0826	0.0353	-0.6132	-0.0615
The college is doing enough to assist me during TP	0.0400	0.8781	0.0974	-0.0217	0.0182	0.0486	-0.0423	-0.1524	0.1281
Teaching is what I expected in life	-0.0463	0.2131	0.1830	0.1117	0.2002	-0.1610	0.7634	-0.0488	0.1657
My expectations before TP match my experience after TP	0.0610	-0.0274	0.1200	0.0738	0.7794	0.2697	0.1515	-0.1169	0.0760
Averages	**0.6359**	**0.8020**	**0.6764**	**0.7205**	**0.7346**	**0.7927**	**-0.0210**	**0.0219**	**0.8592**
Grand Average									**0.5802**

Extraction Method: Principal Component Analysis.
 Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 11 iterations.

Satisfaction Index (In)   is   **66.7%**