PRE-SERVICE SECONDARY SCHOOL MATHEMATICS TEACHERS' PREPAREDNESS FOR CONTINUING PROFESSIONAL DEVELOPMENT: THE CASE OF A UNIVERSITY IN CENTRAL ZAMBIA

By

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DECLARATION

I, Maureen Kabwe Kanchebele Sinyangwe, declare that this dissertation is my own work and the works of other people have been appropriately acknowledged. I further declare that this work has never in part or whole been submitted to the University of Zambia, Lusaka, Zambia or any other institution for the award of any academic qualification.

Signature: ……..……

Date:…….……..

CERTIFICATE OF APPROVAL

This Dissertation by **Maureen Kabwe Kanchebele Sinyangwe** is approved as fulfilling the requirement for the award of the Master's Degree in Mathematics Education by the University of Zambia, Lusaka, Zambia.

Examiner 1	Signature	Date
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ABSTRACT

Initial Teacher Education is designed to prepare pre-service teachers for teaching and to establish a foundation for continuing professional development (CPD). The objectives of this qualitative case study research were to: establish mathematics preservice student teachers' conceptions of CPD; establish how mathematics preservice student teachers were prepared for CPD and; determine the perception of mathematics preservice student teachers on way(s) by which they were prepared for CPD. Forty-six (46) purposively selected fourth year students, at the selected university in Central Zambia, with Mathematics as their major subject area of specialization participated in this study. The student participants participated in the study by completing the questionnaire and thereafter by being interviewed. Relevant documents were also reviewed. Thematic and content analysis were used to analyse the collected data. The study shows that the PSTs generally did not present a confident sense of preparedness for CPD. The PSTs conceptualisation of CPD was limited and limiting at the same time. The study established that while some knowledge and skills for CPD can be presented in course content taught, the PSTs needed more opportunities for reflectively practicing these skills and developing a positive mind set for CPD in their learning environment. There was a need for the Mathematics Teacher Educators at the university to consider facilitating PSTs acquisition of correct comprehensive and holistic CPD-related information as well as developing a positive mind set for it. It was also recommended that the CPD implementation and assessment strategies focus on increasing the reflective practices as a way to facilitate developing relevant competences for CPD and lifelong learning. A CPD preparation Framework comprising two interrelated plans named: the PSTs' CPD preparation plan and the PSTs CPD Plan–which present a structure to facilitate intention-illuminated action toward preparing PSTs for CPD has been developed and proposed.

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ACRONYMS AND ABBREVIATIONS

CDC	Curriculum Development Centre
CPD	Continuing Professional Development
ECZ	Examinations Council of Zambia
HoD	Head of Department
ITE	Initial Teacher Education
MCK	Mathematics Content Knowledge
MoE	Ministry of Education
PCK	Pedagogical Content Knowledge
PST	Pre-service teachers
STP	School Teaching Practice
SBCPD	School Based Continuing Professional Development
ZECF	Zambia Education Curriculum Framework

CHAPTER 1: INTRODUCTION

1.1 Overview

This chapter presents the background of the study, statement of the problem, purpose of the study, objectives, research questions, and the significance of the study. It further looks at the limitations of the study, theoretical framework and definition of key terms.

1.2 Background

The background of this study on University Pre-service Secondary School Mathematics Teachers' preparedness for Continuing Professional Development is presented under the 4 subheadings. These subheading are: Zambia's vision for learning; Lifelong Learning and Continuing Professional Development; Teacher Education and Mathematics Teacher Education Programme.

1.2.1 Zambia's vision for learning

The policy document in education in Zambia, called 'Educating our Future' which is the basis of all the educational strategies at all levels of the education system stresses the importance of continued or ongoing education and learning (MoE, 1996). The Zambia Education Curriculum Framework (ZECF), which draws from the Educating Our Future policy provides further guidance on the preferred type of education for the nation and the curriculum guidelines as well as the structure at all the levels of education. The Framework also emphasises lifelong learning. One of the vision points of the ZECF is to have holistic learners who are lifelong learners. This is argued to extend to learners in the different levels of education including tertiary education where teacher education is.

1.2.2 Lifelong Learning and Continuing Professional Development

The concept of lifelong learning is widely acknowledged to imply 'learning that takes place throughout life, that it is neither confined to any specific age group nor to the education administered by educational institutions' (Tuijnman & Boström, 2002, p.102). Similarly, the ZECF presents it as that learning that '*takes place not only in classrooms but in all kinds of contexts, including personal experiences and being in contact with other people… It should respond to personal and societal needs.* (CDC, 2013, p. 18). Some features of lifelong learning presented in these descriptions include: lifelong learning being a process that takes an

individual's lifetime and can take place in many and varied settings. It is also recognised that there is a foundation for this kind of learning. The ZECF states that *'... formal learning is, among other things, meant to function as a starting point for continued Life-Long Learning*'(CDC, 2013, p. 18). There is a link between lifelong learning and continuing professional development (CPD).

CPD, sometimes simply called Professional Development (PD) is a 'substantial…component of lifelong learning…'(Friedman, 2023, p. 588). There are several definitions of CPD presented in literature such as by: Day, 1999; Bolam & McMahon, 2004; Isaacs, 2006. Day (1999) for instance explains that:

> *Professional development consists of all natural learning experiences and those conscious and planned activities which are intended to be of direct or indirect benefit to the individual, group or school and which contribute through these to the quality of education in the classroom. It is the process by which, alone and with others, teachers review, renew and extend their commitment as change agents to the moral purpose of teaching; and by which they acquire and develop critically the knowledge, skills and emotional intelligence essential to good professional thinking, planning and practice with children, young people and colleagues through each phase of their teaching lives.* (Day, 1999, p.4)

On the other hand, Isaacs (2006) presents PD as '… a more systematised, initial and continuous, coherent and modular process of professional development of …educators in accordance with professional competency standards and frameworks' (p.5). From the definitions provided above, it is evident that the CPD concept presents multiple dimensions. Its' meaning may not always be very clear (Day & Sachs, 2004; Friedman, Davis, & Phillips, 2001). Even though what CPD means is not always very clear, there are some broad elements that can be considered as key elements of CPD. These include the following: firstly, there is a recognition that CPD is a continuous and continuing long-term process extending beyond initial teacher training. This process begins with initial teacher training and through all the stages of teaching life (Villegas-Reimers, 2003). Secondly, there are generally several activities or initiatives or practices that support professional development including all natural learning experiences and those conscious and planned activities. It includes both informal learning experiences, non-formal as well as formal opportunities for teachers' development that can take place inside or outside a classroom setting, within or beyond the school context. Thirdly, teachers' CPD is not entirely on an individual basis but constitutes working, cooperating and collaborating with others too for a similar purpose. While there are cases and opportunities for individual isolated work for CPD, CPD also involves elements of

collaboration among several relevant stakeholders including collaboration between teachers and pupils, teachers and teachers and teachers and other relevant stakeholders (Loucks-Horsley et al., 2010; Villegas-Reimers, 2003). The fourth point is that there is a need for evidence of learning from whatever PD initiatives a teacher engages in. While there may be debates about what this evidence constitutes (Browne, Defty, Guo, Hou, Wang, & Zhuang, 2022; Abakah, Widin, & Ameyaw, 2022; Parker, Patton, Gonçalves, Luguetti, & Lee, 2022), there is a case for positive impact closely tied to improvement in teaching/learning and improvement in learner attainment (Liebowitz & Porter, 2019; Kaliba, 2016; Mizinga, 2016; Ngumbwe, 2014).

The above to an extent show that CPD is a component of lifelong learning. It involves lifelong learning which involves continually (re)considering knowledge and skills necessary at each and every stage of one's (teaching) life (Friedman 2023; Sockalingam et al., 2022). Teachers are expected to continue learning, after their initial teacher education, throughout their career years, so as to improve their practise and be able to adapt to the changing (learning) needs of their society and learners (Day & Sachs, 2004; de Vries, Jansen, & van de Grift, 2013). There is a recognition of the CPD process beginning with initial teacher education (ITE)) going on through all the stages of teaching life in literature such as reviewed here. However, what needs to be done to initiate and lay the foundation for it (CPD) at ITE is generally not discussed as much, in literature, as the CPD beyond the ITE stage.

1.2.3 Teacher Education

Teacher Education covers learning for pre-service and in-service teachers (Villegas-Reimers, 2003: CDC, 2013). In-service teacher education is for already serving teachers and generally designed to improve their knowledge, skills, competences and keep them to stay abreast of significant developments in their professional work (Mgaiwa & Milinga, 2024; Osamwonyi, 2016). Pre-service teacher education also known as initial teacher education involves preparing future teachers. It is for those individuals **'…**who have no initial formal teaching orientation or experience. The knowledge, skills, positive attitudes and values that student teachers acquire during the course should enable them implement the school curriculum effectively' (CDC, 2013, p.47).

Sandholtz (2011) adds that ITE has a responsibility to prepare pre-service teachers (PSTs) to teach effectively and enhance learners' learning. It is at the same time argued that it also has a role to play in initiating, or introducing and developing the idea of continuing teacher development and learning (Patterson, 2002) to the pre-service teachers. In this, the aim is to

help the pre-teachers become aware of the need for continuing growth and development as a critical component of their (future) professional lives. Bubb and Earley (2007) state that apart from ITE training being valuable in its own right it can also be viewed as providing a platform on which continuing professional development (CPD) can be erected. Therefore, suggesting that it is expected to support the vision for continuing and lifelong learning.

Teacher education programmes in Zambia commonly offer student teachers compulsory education courses which relate to educational theory and practice. These courses may include: philosophy of education, educational psychology, sociology of education and special education among others. Such courses are generally designed to provide general knowledge and skills for teaching and a foundation for professional growth and development (Banja & Mulenga, 2019). Student teachers also have to take courses that relate to their chosen teaching subjects of specialisation. It is expected that through these courses, they would further develop skills and knowledge relating to the content area of the teaching subject (s) they have chosen to specialise in.

When in third year, and later in the fourth and final year of study, the students are supposed to add on what is generally considered as methodology courses. These '…methodology courses are pedagogical in nature' (Nalube, 2014, p.17). These are the courses which contribute to the development of pedagogical content knowledge which include techniques, strategies and procedures for teaching the content of the chosen subject of specialisation. It is also through these courses that they are expected to do peer teaching. These, therefore, are generally considered as the courses directly related to preparing the student teachers to teach.

1.2.4 Mathematics Teacher Education Programme

A Mathematics Teacher Education Programme can be said to be a programme designed to equip student teachers with the knowledge, skills, practices and dispositions needed to teach mathematics effectively (Even & Ball, 2009). Mathematics Teacher Education Programmes in Zambia generally constitute the compulsory education courses which relate to educational theory and practice as already presented above under 1.2.3. Since one can't teach what they don't know (Changwe and Mwanza, 2019), the programme also includes courses in Mathematics content. This implies that student teachers specialising in Mathematics are expected to have knowledge of mathematics also called Mathematics content knowledge (MCK) and elaborated on by scholars such as: Shulman, 1986; Ball, Thames, & Phelps, 2008; Changwe, 2017. This knowledge in ways aligns with mathematical concepts, ideas and

principles in aspects of the main branches of Mathematics such as presented in Rubenstein and Schwartz (1999) which may include Algebra, Geometry, Trigonometry, Calculus, Probability and Statistics among others. It is from the branches of Mathematics that the topics in the Zambian Secondary Mathematics syllabus are argued to be based on. This is, for example, illustrated in the Grade 10-12 'O' level Mathematics syllabus which has content '…defined according to seven themes namely: Numbers and Calculations, Algebra, Geometry, Computers, Measures, Probability and Statistics and Relations'(CDC, 2013, p.vii). Mathematics content knowledge required for teaching is both broad and multidimensional. It is arguable that not all aspects of this knowledge, nor the necessary depth, can be fully covered within the timeframe allocated for a Teacher Education programme. This in itself points to a need for continuing learning even after the teacher education programme is completed.

The Mathematics Teacher Education Programme also generally offer student teachers courses which contribute to the development of pedagogical content knowledge (PCK) which include techniques, strategies and procedures for teaching Mathematics content (Shulman,1986). One of the reasoning for this is that having an understanding of mathematics content is necessary but not sufficient to teach Mathematics effectively (Shulman,1986: Ball et al., 2008). Hence, the need for student teachers to be educated in both MCK and PCK.

Overall, in this case, Mathematics Teacher Education Programmes commonly offer student teachers of mathematics courses related to general knowledge for teaching, MCK and PCK. Typically, all the courses are designed to prepare student teachers to integrate theoretical foundations, pedagogical strategies, and experience and practices to address the complexities of teaching and learning mathematics and thus to teach effectively. However, all such skills and knowledge must be continually developed and honed. This is a widely acknowledged point in the literature including by Wu and An (2008), Kim and Asbury (2020) among others, and further discussed in the next chapter of this document. Such development can be achieved through ongoing learning beyond ITE, facilitated by various professional development programmes and initiatives. As already stated above under subsection 1.2.3, ITE serves to establish a vision and foundation for lifelong learning. However, there is a need for further research into how it (ITE) has contributed to preparing Mathematics student teachers for continuing professional learning and development.

1.3 Statement of the Problem

Teacher preparation programmes are designed in such a way that what is taught contributes to the development of student teachers' knowledge of education, content knowledge as well as pedagogical content knowledge which include techniques, strategies and procedures for teaching the student teachers' chosen subject of specialisation. It is also argued and acknowledged that they also have a role to play in initiating and developing the idea of continuing teacher development and learning with the aim of helping the student teachers become aware of the need for continuing growth and development as a critical component of their professional lives (Patterson, 2002). Initial Teacher Education programmes can also be viewed as providing a platform on which continuing professional development can be erected (Bubb & Earley, 2007). Several studies in the Zambian context (including Muyunda, 2022; Sinzala, 2021; Likando, 2018; Kaliba, 2016; Mizinga, 2016; Mwelwa, Mwanza & M'sango, 2015; Haambula, 2015; Ngumbwe, 2014) have been done on varied aspects of CPD. However, the focus for all has been on CPD with respect to in-service teachers. There has been a lack of specific consideration of CPD with respect to PSTs in general. There is a need to pay specific attention to the preparedness of Mathematics pre-service student teachers for CPD. Not paying attention to this can have negative consequences on PSTs ability to identify with and prioritise CPD and uptake of CPD in general when they start serving as teachers. Inadequate or lack of preparedness can lead to failure to maximise on the benefits of CPD too.

1.4 Purpose of the Study

The overall purpose of the research was to determine university pre-service secondary school Mathematics student teachers' preparedness for continuing professional development.

1.4.1 Objectives

The research objectives were to:

a. establish mathematics preservice student teachers' conceptions of CPD.
b. establish how mathematics preservice student teachers were prepared for CPD.
c. determine the perception of mathematics preservice student teachers on way(s) by which they were prepared for CPD.

1.5 Research Questions

In order to achieve the above-stated objectives, this study was guided by the following research questions.

a. What are mathematics preservice student teachers' conceptions of CPD?
b. How are mathematics student teachers' prepared for CPD?
c. What are the perceptions of mathematics preservice student teachers' regarding the way(s) by which they were prepared for CPD?

1.6 Significance of the study

The finding of this study can have implications on the mathematics teacher education curriculum content and content provision. It may contribute to providing evidence for curriculum content and implementation strategies that is directed toward preparation of student teachers for CPD which has already been emphasised by the Teaching Council of Zambia such as through the CPD framework for teachers in Zambia. It might contribute to presenting an opportunity to audit teacher preparation programme content and practices for the purpose of (re)shaping them for positive mathematics student teachers' CPD experiences.

In addition, it is hoped that the findings of this study would positively inform the Mathematics teachers' teaching curriculum and Mathematics teachers' preparation process. The results of this study could thus help mathematics teacher educators enhance their instructional strategies to help contribute toward the development of an idea of and what can be considered acceptable conceptualisation of continuing professional learning and development as well as the development of competences, habits and the attitudes that can serve as the basis for continuing professional development.

It is further hoped that the findings could bring more insight into prospective mathematics teacher training and preparation with respect to it being crucial for initiating and developing the idea of continuing teacher development and learning with the aim of helping the student teachers become aware of the need for continuing growth and development as a critical component of their professional lives at university level in Zambia and thus add to body of knowledge in the field.

Furthermore, researchers in the field of mathematics education may also use the results of this study to build on many more studies that might be carried out on mathematics teacher education curricular. This may in turn strengthen future efforts in preparing student teachers of mathematics for positive uptake of and commitment to CPD initiatives.

1.7 Limitations of the Study

This study is focussed on examining the preparedness of secondary school Mathematics pre-service student teachers for continuing professional development. The mathematics student teachers may have revealed more about their opinions, which may have been underestimates or overestimates of their actual conceptions or experiences in relation to CPD and preparedness for CPD in Mathematics. Despite this limitation, it can be stated that the student teachers' shared conceptions were provided an opportunity for them to express their views on CPD preparedness and CPD related experiences and this further extended understanding of what it means or meant to be prepared for CPD in their context.

Some students may have feared to open up and give responses to the questions to be posed by the researcher who, at the same time, happens to teach them some topics in some of the Mathematics courses they took for their programme. It is possible that they might have thought that telling what they may have considered as the truth about the matter under discussion might offend their lecturer and that that may come with negative consequences on their part. Similarly, fellow lecturers in the Mathematics and Statistics Department might not have felt free to share responses to the interview questions. However, the use of other data collection instruments as well such questionnaire for students and lecturers (interview questions modified to questionnaire items) and Documents Review helped to mitigate the effects.

1.8 Theoretical framework

Two theories: Constructivism and sociocultural framework guided this study. Socio-cultural framework may be considered as one of the versions of constructivism, but works such as by Rogoff (1990); Jaramillo (1996); Packer and Goicoechea (2000); Scott and Palincsar (2013) among others, present differences between the two theories to support their individual standing. The use of the two theories provided a form of theoretical triangulation allowing for in-depth examination and hence in-depth understanding of the preparedness of secondary school Mathematics pre-service student teachers for continuing professional development. This is supported by UNAIDS (2010, p. 23) which states that the use of more than one theory helps to look at a situation or phenomenon understudy from different perspectives and that when carefully managed can help researchers to '…look beyond the obvious explanations and identify sharper ways of examining and explaining findings'. Constructivism is used both as a theoretical framework for analysis and methodological guide. The social cultural framework

has been used as a theoretical framework for analysis since student teachers' conceptions need to be studied within their context (Fives, Lacatena, Gerard, 2015). Details on each of the chosen theories have been presented in the sections below.

1.8.1 Constructivism

This study is guided by Jean Piaget's (1896–1980) constructivism theoretical framework and principles. Constructivism has many forms to it (Boghossian, 2006), but is basically rooted in ways in which knowledge is constructed and not simply reproduced (Von Glasersfeld, 1996). It is entrenched in: (a) appreciating individual learners' active engagement in knowledge construction; (b)acknowledging the role of prior knowledge and skills in learning; and (c) actively constructing knowledge individually or socially through personal experiences and interaction of existing knowledge with the environment and information from others. Even though there are arguments that constructivism is a theory of learning and not a theory of teaching (Fives, Lacatena, Gerard, 2015) it has implications for teaching, including how teachers teach and learn to teach (Bada, 2015). This study focussed on the preparedness of secondary school Mathematics pre-service student teachers (PSTs) for continuing professional development. With respect to this study and while acknowledging the limitations of constructivism (Karagiorgi & Symeou, 2005), it can be reasoned that mathematics preservice student teachers' conceptions have an important role to play in their own learning as well as preparation for teaching, learning and CPD uptake. From a constructivist perspective, knowledge is constructed. Constructivism is based on the assumption that knowing is an active process by which knowledge is constructed. Each individual constructs his/her own reality or meaning and as such there are multiple interpretations of the same reality. This study focussed on the preparedness of secondary school Mathematics pre-service student teachers for continuing professional development. The key research participants, the PSTs, in this study were considered to have had a pivotal role to play in their preparation for professional development which could be evidenced in their being positioned to learn about CPD, reflectively identify their learning needs, actively engage in activities, in any teaching/learning context, that support CPD. Their experiences, interactions and perspectives were considered to have significant place in informing and supporting their active knowledge construction, learning and hence their preparation for professional development and lifelong learning.

1.8.2 Sociocultural framework

The primary proponent of the Sociocultural framework is Lev Vygotsky (1896–1934). Culture and context are one of the key aspects of the framework. The argument is that fundamental Culture and context are fundamental to the understanding of learning and development. Teachers' conceptions, practices and experiences of teaching and or learning cannot be examined outside the sociocultural context as sociocultural factors significantly shape their thinking or perspectives with regard to their teaching and learning practices. In fact, Fives et al (2015) in their work in the book entitled *International handbook of research on teachers' beliefs* have stated that conceptions should be studied in context. They are connected to specific contexts. Contexts can activate and influence an individual's actions and preferences (Fives & Gill, 2015). Mansour (2013), with reference to teachers of Science in Egypt, states that understanding teachers' context may make it possible to identify certain aspects of their context that can support or act as barriers to changing their practices or implementing positive changes in their work. This relates to this study. The researcher worked with the PSTs to gain an in-depth understanding and interpretation of their perspectives and experiences in relation to their reality in context. What the PSTs shared was a reflection of their context. Properly understanding their views thus required reference to their culture or context as advanced by Olson (1988) and the sociocultural theoretical framework as used by this study. Understanding mathematics PSTs' context can facilitate understanding their preparedness for continuing professional development and would make it possible to identify certain aspects of their context that can indeed support or act as barriers in their being prepared to teach and or learn with respect to CPD.

1.9 Definitions of Key Terms

To ensure uniformity and understanding of this study, the following definition of terms used in the study have been provided:

Continuing Professional Development/Professional Development(PD): In this study PD 'consists of all natural learning experiences and those conscious and planned activities which are intended to be of direct or indirect benefit to the individual, group or school and which contribute through these to the quality of education in the classroom. It is the process by which, alone and with others, teachers review, renew and extend their commitment as change agents to the moral purpose of teaching; and by which they acquire and develop critically the knowledge, skills and emotional intelligence essential to good professional thinking, planning and practice with children, young people and colleagues through each phase of their teaching lives' *(Day, 1999, p. 4)*.

Curriculum: All the planned learning experiences offered to the learner or students under the guidance of the educational institution (Tanner & Tanner, 1975).

Educator: An educator is a person who teaches or educates. Educators facilitate learning and empowers learners (Giroux, 2011).

Lecturer: Used to convey the same meaning as Educator. Lecturer and educator are sometimes used interchangeably in this study.

Student: A learner at a higher institution of learning or post-secondary school (Oxford Dictionary, 2024).

Student-teacher: A student at a higher institution of learning who has declared an intention to teach, is enrolled in a teacher education programme and gaining hands-on experience in classroom settings (Zeichner & Liston, 2013).

Teacher training institution: An institution designed to provide teacher training post-secondary education (LawInsider, 2024).

Teacher Educator: being one who teaches or educates teachers (or teachers to-be)

Teacher Education: The concept that describes the complete process of developing and producing a trainee teacher in various ways of facilitating and managing the teaching and learning processes.

1.10 Summary

This chapter presented the background of this study on the preparedness of secondary school Mathematics pre-service student teachers for continuing professional development. This was followed by description of the statement of the problem, the purpose of the study, objectives and research questions. Further, the researcher explained the significance of the study, limitations, theoretical framework where the study was grounded and definitions of terms. The next chapter focuses on reviewing of literature related to what is known about CPD of teachers and how it relates to initial teacher training and preparation.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview

The previous chapter provided background information about this study which sought to examine the preparedness of secondary school Mathematics pre-service student teachers for continuing professional development. This chapter presents a review of some existing relevant literature on professional development under the subheading: Rationale for CPD; Activities that can support CPD and; preparation practices for CPD after stating the purpose of the literature review.

2.2 Literature Review purpose and focus

In order to examine, preparedness of secondary school Mathematics pre-service student teachers for continuing professional development it is imperative to first do an empirical review of literature on what is known about CPD of teachers and how it relates to initial teacher. Existing literature on CPD extends beyond the scope of this research and therefore not all is reviewed. However, an attempt is made to present previous research to position this research study in the field as well as identify the knowledge gaps.

2.2.1 Rationale for CPD

The definition of continuing professional development (CPD) has already been provided above including under subsection 1.9. It is recognised here that Continuing professional development (CPD), sometimes simply called Professional Development (PD) has several terms in literature that are related to it. These terms include: Staff Development (SD); Continuing Professional Development and Learning (CPDL); Continuing Professional and Personal Development (CPPD) among others. These terms are often related and used interchangeably (Bolam & McMahon, 2004) and so may be the rationale and value attached. Some of the purposes that CPD is designed to serve in different educational contexts and countries are presented below.

CPD can be a means through which teachers keep abreast with knowledge of content and pedagogy in their subject areas and in the field of education in general. It can contribute to updating and extending their professional knowledge and skills on new developments and new areas of practice to ensure continuing competence in their teaching job (Muyunda, 2022, Kaliba, 2016; Bubb & Earley, 2007). In addition, ‘it helps in updating pedagogical approaches,

pastoral care for learners, assessment procedures, school organisation and management, and relationship with parents/guardians and he community' (CDC, 2013, p.60).

As already mentioned above, initial teacher education and training is valuable in its own right, and can also be viewed as providing a platform on which PD can be erected. However, there is an argument strengthened by the acknowledgment that even if these were thorough, systematic and (exceptionally) good, such programmes would not be able to equip teachers with all they would need for a life time of work in the classroom. This, therefore, implies that teachers should engage in PD practices to keep themselves up to date with the changing times and circumstances within their areas of specialisation. This is in line with the argument presented by Zambia's CPD Framework for teachers' that 'the purpose of CPD is to align teachers' practice with ever changing educational policies' (TCZ, unpublished, p. 25) and expounded upon in other literature such as Collinson, Kozina, Lin, Ling, Matheson, Newcombe and Zogla (2009) and Zimmer and Matthews (2022) especially with respect to changing technologies.

CPD can be designed in such a way that it contributes to enhancing teachers' confidence. Improvements in educators' knowledge base, skills, values, attitudes and confidence levels can contribute to improvements in teaching practices, which in turn can positively impact on learners' learning outcomes (Mamba, 2022; Mulenga, 2022; Loucks-Horsley et al., 2010).

Onderi (2011) argues that CPD can equally help in revitalising the general morale of teachers in the teaching profession. Specifically with reference to CPD for teachers of Mathematics CPD can inspire and renew their interest for learning and in their profession (Akcaoglu, M., Ozcan, M. S., & Dogan, 2023). Engagement and participation in CPD initiatives has ways helping teachers to remain interested and interesting in their teaching of mathematics despite the challenges and demands placed on them as teachers of mathematics.

Additionally, central to the core purpose of learners' learning is the view that those responsible for learners' learning should be learners themselves. Teachers are considered as learners (Feiman-Nemser, 2012; Näykki, Kontturi, Seppänen, Impiö, & Järvelä, 2021). Engaging in CPD initiatives is one way of demonstrating this. This is expected to contribute to improving teachers' performance and hence contribute to improving learners learning outcomes (Mizinga, 2016; Ngumbwe, 2014). Engagement in CPD initiatives and practices therefore demonstrates embracing a culture of learning throughout one's teaching career stages.

Well-planned CPD can contribute to improving the prestige and status of the teaching profession. 'The ultimate outcome of well-planned continuing professional development is that it safeguards the public, the employer, the teacher and the teacher's career' (TCZ, unpublished, p. 25). This is the case in that it contributes to teachers maintaining and enhancing their knowledge, skills, and competencies, which can positively impact on their teaching practices, long-term relevance to the profession and the quality of education provided to learners and hence the public, by extension. It thus can be argued that it can enhance professionalism. Grieve and McGinley (2010) argue for this and Kennedy (2007, p.95) emphasing the '…underlying conceptions of professionalism… made explicit. '

This section has highlighted the rationale for CPD. Even though some of points discussed refer to CPD for teachers in general they are applicable to teachers of mathematics teachers. In light of the rationale for CPD as presented above, it is concluded that the need for CPD is well established. It is relevant both from a perspective of quality service deliverance and professional, social as well personal career development. The level to which each of these is covered and emphasised may vary among individuals or groups of teachers in different educational settings and countries. What may remain to be critical though is ascertaining the extent to which it is serving the purpose(s) for which it is intended for the teachers in the service. As for the preservice teachers, it remains imperative that what could be considered as a strong foundation for continuing professional development laid and developed while they are engaged in their initial teacher training.

2.2.2 Activities that can support CPD

There are several forms of PD which can also be referred to as CPD activities or opportunities. CPD activities can refer to all activities that can facilitate PD, regardless of whether they are a part of their daily teaching work or formal or informal occurrence (Mansour et al., 2014: Villegas-Reimers, 2003). The literature search shows that there are several CPD activities(Goodall, Day, Lindsay, Muijs, & Harris, 2005; Kennedy, 2005; Lieberman, 1995; Sparks & Loucks-Horsley, 1990; Villegas-Reimers, 2003; TCZ, unpublished; Jere, 2022) that teachers can engage in for their PD and these are categorised differently for several varied reasons (Adagiri, 2014). For instance, Goodall et al., (2005, p.274) has categorised them under the three (3) headings, 'Direct learning', 'Learning out of school' and 'Learning in school'. The range of CPD activities under each heading are captured here: (1) *Direct learning:* Knowledge update, skill update, awareness sessions, initial conversations, charismatic

speakers, conferences, courses and workshops, lecture, consultations, self-evaluation and self-directed reading; (2) *Learning out of school:* Networked learning communities, visits to other schools, secondments/sabbaticals, school-university partnerships, extended training programmes, school-provider partnership, Beacon/specialised School, professional organisations and study groups and ; (3) *Learning in school:* Peer coaching/review, critical friendships, mentoring, Action research, task related learning/planning teams, collaborative teaching and/or planning, observations, data collection and analysis, performance management/review and monitoring.

Kennedy (2005, p. 236-248) on the other hand has categorised them under nine (9) headings and these have been summarised and presented as being: (1)*Training model* which focuses on updating skills, with delivery by an 'expert' who determines the agenda while the participant generally remains passive;(2) *Award Bearing model* usually emphasising the completion of award bearing programmes as maybe offered by institutions of higher learning; (3) *Deficit model* which focuses on addressing perceived shortcomings in a teacher's performance; (4)*Cascade model* where a teacher or teachers attend a training programme and thereafter disseminates the information acquired to colleagues (5)*Standards Based model* where teachers strive to adopt and demonstrate certain common skills as demanded by national standards; (6)*Coaching / Mentoring model* whose focus is on the development of usually a one-to-one non-threatening relationship to support professional growth and takes place within a school context; (7)*Community of Practice model* which generally involves more than two people in a non-threatening relationship where acquisition of knowledge and skills takes palace as a result of the interaction among members. Depending on the role of the individual in the community of practice, learning could be a proactive or passive experience; (8) *Action Research model* involving the teacher(s) themselves identifying and implementing relevant research activities as it pertains to their classroom setting. It encourages teachers to become critical of their own practice and; (9) *Transformative model* which recognizes and integrates several other different types of the models discussed above with a realization and consideration of whose agenda is being addressed in the process.

While there are some other literature including (Lieberman, 1995; Spark & Loucks-Horsley, 1998: TCZ, unpublished) with different categories of teachers' CPD activities, which have not been presented here, based on the above already illustrated categories it can be concluded that there are different ways in which CPD activities can be categorised as may be dictated by the

context and nature of the study being undertaken among other factors**.** While being aware that categorisations can overlap (Adagiri, 2014), for this study, the CPD activities have been classified under 'formal' and 'informal' CPD with CPD activities further classified under the subheading depicting whether they take place within or outside the school setting. The CPD activities considered are presented in detail below.

2.2.2.1 Formal CPD activities.

This includes structured and systematic CPD activities, which can be school-based or non-school based and generally led or directed by an instructor or trainer. The CPD activities under this heading are: include departmental meetings, staff meetings, (academic) training courses, conferences, seminars and workshops.

2.2.2.1.1Non-School-based CPD activities

These include the following below.Trainings or training courses which can be long-term or short-term, award-bearing or non-award bearing through distance learning, part time or fulltime study modes, give teachers opportunities for career advancement and professional development. They can improve teachers' academic standing and teacher competences and promote professional growth (Boyle et al., 2005; Komba & Nkumbi, 2008).

Workshops, which are given as an example of a traditional form of in-service teacher training (Villegas-Reimers, 2003), offer opportunities for acquisition of knowledge, skills and dispositions that teachers can build on to improve their professional, personal, and social lives. However, they may not be accessible to all teachers as some demand that one has financial resources to attended. While financial support can come from the school administration or personal resources they may not be readily available.

Conferences whether local/regional/national/overseas, in-person or virtual education are another CPD activity which offer opportunities for presenting research findings and exchanging ideas on current debates in particular field between and among teachers, researchers and experts in different fields depending on the target conference participants. Conferences are a way of disseminating ideas, in education in general or particular subject areas, which in a way can enhance professional networking which is valuable for professional growth (Goodall et al., 2005).

2.2.2.1.2 School-Based CPD activities

Some of the limitations of off-site PD learning activities for teachers facilitate the promotion of SBCPD. Opportunities for CPD within the school setting include: Lesson study, Teacher support groups, Teacher induction, mentoring, coaching, observation and research among others. Each one of these are described in some detail below. Lesson Study (LS), a collaborative type of professional development. It is a common type of SBCPD in Zambia as indicated by Kabeta, (2015) and Sikombe (2022) among other authors. It involves teachers working together through all the phases of the LS cycle which broadly involves planning, teaching, observing, reflecting, critiquing, revising a lesson and/or re-teaching it in a continuous cycle (Banda, 2007; Burghes & Robinson, 2009; Baba, 2007). Several authors among them Banda (2011) and Kashoti (2016) have presented its benefits in the Zambian context. The downsides aligned with LS in the Zambian situation have equally been identified by studies such as those by Kabeta (2015) and Banda (2007, 2011) among others.

Teacher support groups which are sometimes referred to as learning circles (Tripp, 2004), teacher networks (Day & Sachs, 2004; Villegas-Reimers, 2003), peer networks (Mulkeen, 2010) and teachers' communities of practice (Kennedy, 2005), communities of enquiry or learning communities (Kennedy, 2011), professional learning communities for teachers (Mamba, 2022) are another form of SBCPD. They can be made up of teachers, formally or rather informally, within the same school or different schools with a common activity or focus to work on (Huberman, 2001). Such groups can work together and support each other to achieve individual and/or shared goal(s), which may relate to improving their teaching practices and pupil attainment and performance (Salo & Ronnerman, 2013; Mamba, 2022).

Teacher induction, which may have various interpretations, has been argued to promote PD and growth. It generally involves, systematic institutional effort to support a new teacher to develop the competencies and values needed for adjusting to the demands of teaching and fulling the teaching job (*(*Mwelwa et al., 2015; Bubb, 2007). The induction of new teachers is argued to promote PD through improving teachers teaching practices, learners' learning, achievement and performance and reducing teacher attrition *(*Mwelwa et al., 2015; Sun, 2012). Whether is actually realised to the fullest extent in the professional life of the beginning teacher may depend on whether the induction programme is comprehensive enough to meet the professional and learning needs of the beginning teacher.

Mentoring is another form of professional development. The characteristics of this model include: a one-on-one peer mentoring (Kennedy, 2005) or group peer mentoring or a combination of one-on-one peer mentoring integrated with group peer mentoring (Kensington-Miller, 2012) meant to support teacher growth. Mentoring as a formal school arrangement can also involve a more experienced teacher acting as a mentor to a newly qualified and/or young teacher referred to as a mentee (Bolam, 1993). The coaching/mentoring model embraces: knowledge sharing, sharing of insights, reflections, practices, experiences and materials, making observations - all designed to support teacher growth and professional development (Kennedy, 2005; Villegas-Reimers, 2003). Further, OECD (2009) states that mentoring programmes can especially be helpful to new teachers as they can help them cope with challenges such as those related to classroom management, motivating pupils to learn and combat early dropout from the teaching profession.

Coaching which is closely related to mentoring, but different Viera (2021), is also considered as a form of professional development. It can be described as a '…non-judgmental, and collaborative partnership that occurs when one desires to learn new knowledge and skills from the other' (Hanft, Rush, & Shelden, 2004, p. 1). The goal of coaching maybe to direct efforts toward improving the PSTs' or in-service teacher's learning and application of teaching strategies or interventions. Coaching requires crafting knowledge of new skills and practices to fit the personal styles and values of the teacher being coached in their context (Sheridan, Edwards, Marvin, & Knoche, 2009) which in itself spells its limitation(s). They add that the process' generally calls for frequent interactions over a relatively short period of time to effect change in the practitioner's behavior, attitude, and/or disposition' (p. 384). Both mentoring and coaching have benefits, but also weaknesses and limitations (Viera, 2021; Banja, 2019; Hudson, 2013) which need to be considered to maximise on each of them as tools for professional development.

Observation model of excellent practice is where one observes and examines aspects of the teaching and learning process and performance for the purpose of expanding their knowledge, practice and pedagogy (Hamilton, 2013). Peer observation is generally regarded as a '…cost-effective and time-effective professional development opportunity…'(Gray, 2012, p. 22). A point also supported by Gallastegi, Stutchbury, Woodward and Henry (2022). In addition to being observed by peers, teachers can be observed by other relevant stakeholders. The HOD, school administrators, resource centre coordinators and inspectorate team from district or provincial offices have opportunities to observe a teacher. Observation feedback received has

potential to improve the observed teacher's teaching practice if and when considered in one's practice.

Research is considered as an important intervention tool at all levels of the education system in that it facilitates the finding out of what is obtaining and would need to be adjusted or changed to suit the situations obtaining on the ground (CDC, 2013). Research in general and Action Research in particular can help in exploring ways of understanding and improving teachers' own teaching and learning practices through enquiry and investigation (Villegas-Reimers, 2003). It is only by engaging in research '…that teachers rediscover their professional status, empower their practice in the classroom and improve the quality of education for their pupils' (Kincheloe, 2012p.i). Engaging in research facilitates acquisition and further development of research skills, increase in knowledge base, levels of confidence and decision making abilities. It is for this reason that teachers are encouraged to carry out research. Every teacher is a researcher and can research (Aubrey-Smith, 2018). However, not every teacher is willing to or actually engage in research for reasons such as reported in literature such as such as Ulla, Barrera and Acompanado (2017) as well as Ahmed and Pervin (2015). This has some implications for teachers' professional development and the practical value of educational research. It also has some implications for Teaching Council of Zambia Expectations that teachers are to engage in and with research. Research, as a CPD activity, can go hand in hand with publication(s). This is because once a teacher engages in research they may need to publish their findings as a way of reporting on research done and for reference and for use by the school community or wider teaching or education community. Lack of engagement in research could lead to few or no publications from teachers.

2.2.2.2 Informal CPD activities

Formal structured CPD activities have a significant role to play in teachers' professional development, but their efforts to enhance PD can be supported and complemented by informal or less structured CPD practices as shown below. Teachers in WestEd's (2000) study of teachers' professional development in 8 award-winning schools in the United States acknowledged that '…while formal training sets the stage, it is really through more informal modes that new ideas take root, spread, and become part of daily practice…' (p.19)

In this study any CPD activity that has not been classified as formal CPD can be considered as 'less formal' (Villegas-Reimers, 2003) or 'informal' (Desimone, 2009; Kennedy, 2011; Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011) CPD. This however does not mean

they are to be considered as some kind of casual processes or activities, but as processes that can contribute toward achievement of PD goals. Based on relevant literature reviewed (Komba & Nkumbi, 2008; Mahmoudi & Özkan, 2015; Richter et al., 2011). Examples of informal CPD activities include: teachers learning from their experience (both pre-entry and on the job experience); self-reflection and assessment; on the job-learning; personal study or reading of professional publications; learning with and from colleagues; working alongside with experienced colleague; networking with others doing similar work; learning from pupils; use of role-models; and learning through teaching or training others.

When analysed, it can be deduced that there are several less structured opportunities that allow for teachers' PD. It is evident that learning opportunities for teachers are there in every day happenings and interactions (Duncombe, 2005) as well as formally arranged and supported CPD activities. It can therefore be concluded that '…teachers are continually engaged in professional development even in the absence of, or in between, supported professional development programmes'(Mushayikwa & Lubben, 2009, p. 376). This can be a reason for championing the idea that PD should be broadly conceptualised to encompass both formal and informal professional development activities. This mirrors what Kennedy (2011) states in his work that informal learning opportunities deserve '…as much attention as the more formal, structural elements of professional learning'(p. 29). However, the efficient use of such activities to promote PD starts with being aware of and recognising their potential to promote PD. This may need to be accompanied with efforts to empower teachers to be proactive and take initiative in identifying their individual learning needs and act to meet them (Mushayikwa & Lubben, 2009) through the different PD activities.

2.2.2.3 Collaborative CPD and Individualised CPD

From the discussions above so far it is evident that there are forms of collaborative and individualised CPD, which can be formal or informal and which can take place inside or outside classroom/school context or within and beyond school context. 'Collaborative CPD can cover a number of activities ranging from working together with colleagues in informal, unplanned ways to structured, more formalised 'communities of enquiry' or 'learning communities' (Kennedy, 2011, p. 26). Collaborative forms of CPD may include collaborative teaching, collaborative planning, joint preparation of teaching/learning materials and mentoring. There are several benefits of engaging in collaborative forms of CPD. These include: opportunities for discussion, sharing of ideas, effective practices and strategies, experiences, and giving each

other feedback to inform each other's practice and enhancing reflective practices; to support PD all of which can be beneficial to teachers (Akinyemi, Rembe, Shumba & Adewumi , 2019; Bantwini, 2019; Mweemba, 2016, Cordingley et al. 2003; Guskey, 2000; Stoll, Bolam, Mcmahon, Wallace, & Thomas, 2006). This literature further state that collaborative CPD gives opportunities to benefit from what others know and use it to one's own advantage, can raise morale, increase motivation, attract the respect that comes with 'belonging to a community of professionals' and makes complex tasks more manageable. Also is the point that lasting friendships are established, through collaborative CPD, as teachers continuously inform each other's work and practise as evidenced in Mokhele and Jita's (2010) longitudinal study involving some science and mathematics teachers who were part of a CPD programme in South Africa.

While there are several benefits that come with collaborative CPD, there are also some limitations associated with it. One such limitation is that teachers' individual needs or concerns may not be addressed because of favouring the general view of the majority within the group. Collaborative forms of CPD can also subdue the positive traits of teacher individuality or individualism and promote 'group thinking' (Fullan & Hargreaves, 1992) and group-dependency syndrome. Timperley et al. (2007) also add that '…it is possible for teachers to…collaborate and talk together, only to have the status quo reinforced, with change messages misunderstood, misrepresented, or resisted' (p. 201).

The CPD activities that are not fitting in the collaborative forms of CPD fall under individualised or individually guided CPD. These can cover learning from experience, and personal study of relevant literature among other activities. Individualised forms of CPD also have a role to play in teachers' PD, however, their benefits may appear to be masked by the ideas of collaborative CPD**.** Individualised forms of CPD align with the principle of Adult Learning Theory that adult learners are self-directed and relevancy orientated. Self-directed learning can meet the relevant needs of a teacher and is likely to occur out of the need to learn and improve a teacher's individual teaching experience. Its flexibility, design to offer opportunities for an individual to make a choice and its provision of a format for critical personal reflection and analysis (Guskey, 2000) all count as advantages of individually self-directed learning. However, one of its limitation lies in the fact that it can strengthen teacher isolation with its negative tenets. The other limitation may lie in a teacher wasting time doing the same thing unnecessarily over and over again a point that Sparks and Loucks-Horsley

(1998) refer to when they state that '…when individual teachers design their own learning there is much reinventing of the wheel which may be considered inefficient…'(p. 43).

This section has presented and discussed a wide range of avenues for the PD of teachers ranging from formal to informal including from self-directed to compulsory, from collaborative CPD and individualised CPD. Some of the key arguments drawn from the discussion are that: (a) one form of or single CPD activity cannot be considered as enough in the context of meeting teachers' learning and PD needs and; (b) These activities or forms of PD suggest that possession of certain knowledge, skills and disposition is needed for engaging actively in CPD activities, in particular, and responding to CPD positively in general. Researchers such as Spilkova (2001) and Sheridan, Edwards, Marvin and Knoche (2009) have alluded to this and discussed knowledge as well as some skills, competencies and attitudes that teachers need in relation to CPD. This could suggest that there is knowledge and some skills, competencies and attitudes that could be considered to form the foundation that is to laid for CPD for teachers especially at the level of initial teacher training and preparation. The next subsection considers what research literature has provided as some examples of approaches or actions taken to facilitate preparation of teachers for professional development.

2.2.3 Preparation practices for CPD

There is generally more focus on CPD for in-service teachers than with respect pre-service teachers. Some examples of what may be considered as practices or as strategies/approaches/initiatives that some teacher training institutions have put in place that involve preparation of teachers for PD have presented in literature. These examples include the ones presented below.

School teaching practice or simply teaching practice or practicum is a common critical component of teacher education and training (Ulvik, Helleve & Smith, 2018; Gray, Wright, Pascoe, 2017) wide world. The school teaching experience gives trainee teachers an opportunity to practice teaching in schools before they complete their teacher training programme. The period of field teaching experience may vary from institution to institution. However, the main point is that the trainee teachers still have opportunity to acquire and develop professional knowledge, skills, competences and values (Kanchebele-Sinyangwe, 2020). The knowledge and skills gained during university time prepare the trainee teachers to teach during STP, and at the same time STP itself can contribute to acquisition of knowledge and skills related to the profession. STP increases the relevance of the teacher educational

programmes and facilitates the transfer of knowledge and skills from on-campus learning to professional practice (Matthew et al. 2012). Some of the critical components of STP which may be considered as base and practice for professional development include: mentoring learning in practice; possibilities to learn from one's and other teachers' experiences through reflection and interaction and discussion with others as well as; engaging in professional development initiatives at the practicing school which is one of the demonstration of commitment to teaching and learning (Ulvik et al., 2018; Bråten & Ferguson, 2015; Christophersen, Elstad, Solhaug & Turmo, 2016; Sheridan et al., 2009; Matthew et al. 2012; Spilkova, 2001).

Näykki, et al., 2021 describes how teacher learning communities were used to lay the CPD foundation for students at a university on Finland. In their study they explain that a teachers' continuous learning community which was part of the Finnish Ministry of Education and Culture developmental project working with the Finish University was created and pre-service and in-service teachers were given chance to experience working and learning in such a community. The pre-service and in-service teachers worked together for a period of 6 months. The argument presented was that Teacher community are considered a platform for practising active and continuous learning. In addition, this opportunity of working and learning in a teacher learning community was one way of making/organising collaboration between pre-service and in-service teachers for PD more visible in teacher education practices. Näykki, et al. (2021) indicate that further research was said to be needed to explore different teacher groups' reflections of working together as a learning community and to foster teachers' continuous learning and professional development. Otherwise they argue for teachers continuous learning communities for its benefits for professional development. In fact, they maintain 'that both pre-service and in-service teachers should be provided with opportunities for versatile learning experiences to engage in learning communities that include participants at various stages of their teaching careers' (Näykki, et al. (2021, p. 509). Other studies such as by Chen (2012); Goodnough, Osmond, Dibbon, Glassman and Stevens (2009) and Spilková, (2001) have also demonstrated the effectiveness in collaboration between pre-service and in-service teachers for mutual learning and provision of professional support

Another preparation practice for CPD done during initial teacher education is that done through a teacher education model called the School-Community Integrated Learning (SCIL) pathway. While in Näykki, et al.'s (2021) study, shared above, teachers continuous learning community involved pre and in service teachers this model as presented by Hudson and Hudson (2013) is

a voluntary mentor-mentee arrangement. This mentor-mentee arrangement was specifically involving teacher mentors and the preservice teachers at one Australian university as mentees. This particular model of school-community learning is argued to have facilitated preservice teachers' recognition of the breadth of teachers' roles and responsibilities and provided them with extended learning experiences related to engaging in practices that may not be available during practicum experiences. It was concluded that this 'seemed to address some gaps that appear in general practicum and internship models' (Hudson & Hudson, 2013, p.16).

Lesson study for trainee teachers is also another preparation strategy for CPD presented in literature. Mayorga Fernandez, Pena Trapero and De la Rosa Moreno (2021) report on analysis of the incorporation of a Lesson Study cycle, within a Spanish university teacher training programme, as a teaching strategy in initial teacher training. A similar report is also made by Sepulveda Ruiz, Gallardo Gil and Garcia-vila (2022) with a focus on the tutoring and mentoring process during the implementation of lesson study as a methodological strategy in an initial teacher training programme in Spain as well. In both cases lesson study was viewed as a strategy, in initial teacher training, for facilitating the reconstruction of teachers' practical knowledge. And also as adequate professional development from initial training. The qualities of Lesson Study such as facilitating reconstruction of practical knowledge based on responsibility and commitment, taking ownership, development of cooperative work (Sepulveda Ruiz et al., 2022) are highlighted for their benefits in PD. They indicate that results of the study seem to imply that the strategy requires continuity over time in order for the trainee teachers' future education professionals to take it fully on board fully analyse their actual value. The cases of Mayorga Fernandez et al. (2021) and Sepulveda Ruiz et al. (2022) do give an example of Lesson Study being implemented among trainee teachers as a model of sustainable professional development from initial training as opposed to Lesson Study (LS) only being done with already serving teachers such as the case reported by Coenders and Verhoef (2019), Likando (2018) and Kaliba (2016) for instance.

Mentorship is another strategy for preparing student teachers for CPD. An example is from the Zambia Education Enhancement Project (ZEEP) in Zambia. The Ministry of Education has been running ZEEP the from about 2018 to 'support the Government's efforts to improve the quality of education…' (MOE, 2017, p9). The project is structured around three closely related components: (1) Improving the Quality of Teaching and learning; (2) Increasing Equitable Access to Secondary Education; and (3) Enhancing M&E Capacity and Project Coordination. The sub component for component 1 is on improving the Teacher Training

System. It is under this sub component that there was training of 5 college lecturers in mentorship and one of these was for Mathematics. A specific area of support was orientation to the School Programme of In-service for the Term (SPRINT) system for continuing professional development for serving teachers and to Lesson Study, which has been briefly described under subsection 2.2.2.1.2 and 2.2.3.2.1. The focus for these is in-service teachers. However, ZEEP also supported the student teachers school experience (SE) or School Teaching Practice (STP) by developing school experience guidelines, lesson observation tools and financial contributions to five (5) student teachers in primary schools and support for mentors (lecturers) who were to visit the student teachers at least three times during their School Teaching Practice or School Experience (SE). Implying that student teachers on SE were mentored by both (in-service teacher) mentors in the schools and also by their lecturers who mentored them during college time and during STP. This demonstrates an intervention to prepare and to support student teachers for CPD. This was for the primary school student teachers from the colleges and not the secondary school teachers from university such as the ones this study is focusing on. However, it is worth taking into account for the valuable lessons and insights it has to offer for the preparation student teachers for CPD.

There are also examples of training approaches or strategies or methods for promoting knowledge and skills to create a solid foundation for professional development in literature. One such example is that by Spilková (2001) who presents that incorporation of '…various forms of reflective writing: free writing, independent writing, open-ended writing…' (Spilková, 2001, p.59) can support development of reflective practices which are crucial for PD. Others such as Kamens (2007) recommend giving more collaborative tasks with opportunities to practice the needed skills in classroom/lecture room settings when discussing adequate preparation of preservice teachers. The argument is that although some of the knowledge and skills for PD can be presented in coursework, the PSTs may need opportunities to actually practice these skills in their learning environment. It could be in light of this that: Ulvik (2014) presents Action Research as one of the practical ways of fostering professional development among trainee teachers; and Wray (2007) presents the use of Teaching Portfolios among PSTs with the reasoning that the process of developing and maintaining a Teaching Portfolio require increased critical reflection, heightened collaborative dialogs both of which are foundational skills for PD. Other ways are suggested by Sehridan et al., (2009) and Ulvik et al., (2018) too among others. In general, more of student-centred approaches are advocated in the quest to prepare PSTs teachers for professional development. Spilkova (2001) argues in

support of this point by stating that teachers prepared through or with a student/learner-centered approach are responsible for their own professional development, determined towards continuous renewal and growth in their chosen field. Such an argument could be based on an examination of how teachers (can) generate, acquire, and use knowledge about teaching over the course of their career. A point elaborated on by researchers such as Feiman-Nemser (2012).

This subsection has provided some examples of what may be considered as practices or as strategies/approaches/initiatives that some teacher training institutions have put in place that involve preparation of student teachers for PD. It has in some ways contributed to supporting the argument raised earlier, through the different subsections of this chapter, that while CPD is important for both pre-service and in-service teachers focus and emphasis in literature is largely on CPD for in-service teachers compared to preparation of pre-service teachers for CPD especially in the Zambia context.

2.3 Summary

This chapter reviews some existing relevant literature on continuing professional development under the subheading: Understanding of what CPD is; Rationale for CPD; Activities that can support CPD and; preparation practices for CPD after stating the purpose of the literature review. Evidence so far suggests that CPD is of value for or to both pre-service and in-service teachers. Whilst several studies are focussed on CPD for in-service teachers, there is a dearth of literature for CPD for pre-service teachers and preparation of pre-service teachers for CPD in particular especially with respect to the Zambian context. This study contributes to narrowing this knowledge gap as it focusses on examining the preparedness of secondary school Mathematics pre-service student teachers for CPD.

CHAPTER 3: METHODOLOGY

3.1 Overview

The previous chapter reviewed literature relevant to the study on student teachers' preparedness for continuing professional development. This chapter presents the study setting, research paradigm, research approach, research design, population, sample size, sampling techniques and data collection instruments.

3.2 Study Setting

The study site is District A* (not real name) in the Central province of Zambia, Africa. Figure 1 below shows the map of Zambia with all its ten provinces including Central province where District A is situated. There are three recognised Universities in District A: Two are public universities and one private. The study was conducted at University Z* (not the real name) which is located in District A. University Z is a public university.

Figure 1: Map of Zambia showing the ten provinces

Source: Geocentric consult (2020)

3.3 Research Paradigm

Understanding a research study and being able to pass judgement on its quality may require knowing the researcher's chosen research paradigm. Guba and Lincoln (1994) present that a research paradigm is a basic set of beliefs or worldview that guides research. They, in Lincoln

and Cuba (1985) as well state that a research paradigm comprises four components namely: ontology, epistemology, methodology and axiology. Some details on these as they relate to this study are provided below.

Ontology is concerned with 'beliefs about what there is to know about the world' (Snape & Spencer, 2003, p. 11) and is also considered as 'a theory about the nature of social entities' (Bryman, 2008, p. 4). Epistemology basically deals with how we know about that reality and how we justify our beliefs about it.

This study was guided by the Interpretivism epistemological position which aligns with the constructivism ontology. Denscombe (2002) described Interpretivism as a research approach that aims at understanding the complex 'life world' from the research participants' own perspectives. The social world does not exist independent of peoples' experiences adds Bailey (2007). Social reality is a complex construction of meanings, values, and peoples' lived experiences. Even though theories with definite laws can help in understanding the social world, it (the social world) remains complex in such a way that theories with definite laws, such as advocated by positivism (Basit, 2010), may not always be the most effective way of understanding it. This is because there are always other situational considerations that may need to be made. This research takes on the Interpretivism stance by drawing on research participants' perceptions, experiences concerning CPD in seeking to understand and interpret Pre-service Secondary School Mathematics Teachers' preparedness for CPD in the context of the selected university. This is appropriate because the aim was to probe the research participants in order to gain an in-depth understanding and interpretation of their perspectives, opinions and experiences in relation to CPD.

With respect to axiological position, my professional background and experience position me as an emic researcher or insider or as one holding an emic perspective but with respect to details such as expounded by Chapman and Kinloch (2011) and Markee (2013). This understanding and acknowledgement helped to expose and minimise the researcher's actual and potential biases. This is evidenced by the limitations of the study acknowledged and presented under subsection 1.7 above as well steps taken to minimise threats to credibility and trustworthiness of the research as explained under subsection 3.11 below.

Methodology generally addresses the question(s) linked to how the research would be conducted to facilitate obtaining the answers to the questions raised and how valid or credible the findings may be. It outlines how a researcher goes about undertaking a research study

(Howell, 2012). In general, this what this whole chapter and write up has endeavoured to addresses as explained in each of the subsections making the chapter and in line with the identified philosophical assumptions.

3.4 Research Approach

In order to examine the preparation and preparedness of secondary school Mathematics pre-service student teachers for continuing professional, this study adopted the qualitative research approach. This approach was chosen over quantitative research approach or mixed methods approach which '…incorporates elements of both qualitative and quantitative' (Creswell, 2014, p. 33). This was because as Creswell (2014, p. 33) states '…qualitative research is framed in terms of using words rather than numbers which is the focus of quantitative research'. The qualitative research approach provided for the collection of narrative data (i.e. using words) obtained from interviews and open-ended questionnaire items. It was carefully planned but there was a provision for flexibility, following the direction of the study, such as in terms of asking questions differently from the initially planned questions. Best & Kahn (2003) also argued that qualitative research approach was more open and responsive to research participants. As such was needed for this research to help address the research questions.

3.5 Research Design

This was a qualitative research employing a case study research design. Yin (2011) described case studies as detailed investigations of individuals or groups or institutions or other social units for the purpose of getting in-depth information in the real-world contexts. A case study can have one person or entity. It can be a study of an identified thing of the many. Therefore, this was a case study of the preparation and preparedness of secondary school Mathematics pre-service student teachers for continuing professional development at a selected university in Central Zambia. Out of all teacher training universities in Zambia and in central province in particular, this study focused only on one selected university and only on one category of PSTs-that is those studying Mathematics as their major subject of specialisation.

3.6 Population

The mathematics student teachers at university Z who were specialising in Mathematics were the target for the study. The population was all 68 students pursuing Bachelor of Science in Mathematics (and the course representing the minor subject) with Education in 2022/2023. The reasons for choosing the selected students are presented below under subsection 3.8. The

4 lecturers in the Department of Mathematics and Statistics at the University were also data sources as key informants. The reason for their being part of the population is equally explained in subsection 3.8 below.

3.7 Sample Size

The study sample consisted of all the 68 fourth year students pursuing Bachelor of Science in Mathematics (and the course representing the minor subject) with Education in 2022 and 2023 and all the 4 lecturers in the Department of Mathematics and Statistics at the University. The students were studying Mathematics as the major subject of specialisation. Thus, whilst sample is generally expected to be smaller than the population (Goyal, 2013; Ravikiran, 2023), the population of this study was also the sample of the study. Researchers such as Goyal, (2013) as well as Martínez-Mesa, González-Chica, Bastos, Bonamigo and Duquia (2014) have provided details on a population being a sample which had been adopted for this study too.

3.8 Sampling Technique

It has been indicated under 3.7 above that the population of the study was also the sample of the study. With this, it could be argued that there was no need to consider sampling technique. However, it remains stated that the researcher used purposive sampling to arrive at the sample. Purposive sampling means 'sampling in a deliberate way, with some purpose or focus in mind' (Punch, 2004, p.193). All 68 fourth year students taking Mathematics as their major subject area of specialisation including were purposively sampled to participate in this study as key research participants starting with questionnaire completion stage. The researcher chose these research participants because they were in their final year of their training programme. They had done several practical aspects of their programme including peer teaching, had done School Teaching Practice (STP) already and they had learnt or covered most, and all in some cases, of the course content for their courses in their study programme. It should be noted that at this stage of their programme, the PSTs had already covered all the content for their minor subject of specialisation. They were taking only Mathematics-related courses (as Mathematics was their major) and some fourth year education-related elective courses. These selected fourth year students thus were highly likely to have learnt about and experienced forms of continuing professional development than the third, second or first year students. They were considered well-positioned to offer richer and comprehensive insight in CPD related matters as needed in this study. Subsection 3.7 above has already detailed the selection of PSTs as key research participants and lecturers and key informant participants in this study

3.9 Data Collection

The data collection instruments for this study were questionnaires, interview guides and document review schedules. Details on each of these are provided in the sections below.

3.9.1 Questionnaire

Questionnaires are generally considered as an efficient way of collecting data on an identified research topic. Some of the advantages of using a questionnaire include: helping a researcher collect data relatively quick; efficiency in keeping research participants anonymous as they do not have to write their names on the questionnaire and the possibility of a high return rate and standardization of research questions (Munn & Drever, 1996). The questionnaire for all the 68 mathematics student teachers consisted of demographic information such as gender, subject specializations (or combinations) and open-ended questions related to CPD. Open-ended questions had been chosen because they give the respondents chance to express their (true) feelings or views and thus allow the researcher to have a better and clear understanding of the same (Scheaffer, 1996). While the questionnaire had some closed ended questions (related to gender and subject combinations), the open-ended questions collected data related to: (a) conceptions/experiences of CPD (b) conceptions/experiences of the value of CPD and forms of CPD (c) preparedness/preparation for CPD. The questionnaire was designed by the researcher with the aim of being context specific as well as making students to focus on their awareness of their conceptions and experiences related to CPD. The questionnaire was distributed to all the 68. However, only 46 (out of 68) questionnaires were completed and received back, giving a response rate of 68%.

3.9.2 Interview

This study on examining the preparedness of secondary school Mathematics pre-service student teachers for continuing professional development used semi-structured interviews. Semi structured interviews are more flexible as opposed to structured interviews which are rigid or follow rigid laid down procedure and unstructured interviews which are too flexible-the kind of flexibility that may result in challenges such as in comparing one interview with another and in terms of analysing unstructured responses (Kothari & Garg, 2004). With semi-structured interviews the interviewer can modify the questions to probe for more meaningful information on the research topic as the interviews progress thus being able to obtain more in depth and detailed data (Creswell, 2003). Two separate semi-structured interview guides were

prepared, that is, one for the mathematics PSTs and the other for the lecturers in the Mathematics Department. The interview guides included main questions and their hints or probes for probing further.

Twenty-five (25 representing 54%) out of the 46 who completed the questionnaire indicated that they were willing to participate in the one-to-one in-depth follow up interviews as explained above (subsection 3.9.1). This formed the basis of the decision to include them among those to be interviewed. The researcher was conscious of saturation point as explained by scholars such as Saunders, Sim, Kingstone, Baker, Waterfield, Bartlam,... & Jinks (2018) and Guest, Namey & Chen (2020). With this, only fifteen (15, which is 60%) out of the 25 were actually interviewed. Only 2 out of the 4 Mathematics teacher educators were willing to be interviewed. Their willingness was also the basis for interviewing them. The length of the interviews with the 15 PSTs ranged from 9 to 22 minutes. The length of the interview with one lecturer was 25 minutes and 33 minutes for the other.

3.9.3 Document Review

Documents can provide data in qualitative research (Bowen, 2009). Document review in this study was aimed at providing the context in which CPD conceptions and experiences of the PSTs are sought or made known. The documents that were reviewed were: Zambia Curriculum Framework and Zambia CPD Framework for teachers; University Z's School Experience Guidelines and Assessment Rubric; University School Experience Guidelines/Policy and; University Z's Programme/Course outlines for PSTs specialising in Mathematics.

3.10 Data Collection Procedure

To start with, the data collection instruments were piloted among pre-service student teachers taking Business Mathematics in the School of Business and their lecturers. These pre-service teachers were being trained to teach Business Studies related secondary school subjects and Business Mathematics was one of the courses they were taking for their teaching programme in the school. They were considered to have similar characteristics as the pre-service teachers who made the sample for the main study. The interviews with the mathematics student teachers were conducted after the questionnaire had been administered to give the researcher chance to probe further some of the issues that were raised in the questionnaires. The PSTs interviewed were selected based on their willingness to contribute and scheduling concerns. The interviews

were not tape/audio recorded as the interviewees were asked if the interview could be recorded, but they did not consent to them being recorded. The responses given during the interviews were written down and transcribed for analysis and subsequent meaning deriving. The document review process was generally done alongside the other data collection processes and as soon as documents were made available. See Appendix A for the questionnaire, Appendix B and C for the interview guide for the PSTs and lecturers respectively and Appendix D for the Document Review Schedule.

3.11 Reliability and Validity

In general, reliability is the extent to which measures produce results that are consistent and validity refers to the degree to which a measure is a true reflection of the phenomenon under study. Reliability and validity are typically aligned with quantitative research (Golafshani, 2003; Lincoln & Guba, 1985). Some studies such as Lincoln and Cuba (1985) use the concept of 'trustworthiness' as an alternative concept to 'reliability' and 'validity' with reference to qualitative research types and others such as Ary, Jacobs, Sorensen and Razavieh (2009) and Johnson and Christensen (2010) use 'credibility' and 'trustworthiness' for qualitative research when referring to 'validity' and 'reliability'. It is concluded that 'validity' and 'reliability' as generally applied in quantitative research and 'credibility' and 'trustworthiness' in qualitative research aim to serve a similar purpose of ensuring that research and research findings are sound, authentic and dependable. It may not be possible to completely remove all the threats to the validity, reliability or credibility and trustworthiness of research but steps can be taken to minimise them argue Cohen et al. (2011). Works such as by Boeije (2010) and Cohen et al (2011) present some criteria and steps that can apply for assessing the credibility and trustworthiness. This study used triangulation, researcher reflexivity and low-inference descriptor which are presented in turn below.

3.11.1 Triangulation

There are various types of triangulation as researchers such as Thurmond (2001) have explained. One of them is at the level of theories used as a lens or theoretical perspectives for the same study. As already stated above, using more than one theory helps looking at a situation from different perspectives. When this is carefully managed it can help researchers to look beyond what may be considered as obvious points of explanations of findings UNAIDS (2010). 'The intent of using triangulation is to decrease, negate, or counterbalance the

deficiency of a single strategy, thereby increasing the ability to interpret the findings Thurmond, 2001, p.253). Two theories: Constructivism and sociocultural framework guided this study. The use of these theories provided a form of theoretical triangulation which allowed for in-depth examination and interpretation of findings and hence in-depth understanding of the preparedness of secondary school Mathematics pre-service student teachers for continuing professional development. The other type of triangulation is at the level of combining at least two or more data sources. Questionnaire and follow up semi-structured Interviews Document review was used in combination as data collection methods. This allowed for crosschecking the data collected from different sources and counterbalance the limitation of one data source in understanding of the preparedness of secondary school Mathematics pre-service student teachers for continuing professional development. Initially piloting the instruments (see 3.10) before using them among the research participants had a way of adding value to the instruments used and also in cross checking the data that was later collected for the research.

3.11.2 Researcher Reflexivity

Researchers in qualitative research are generally more inclined to being subjective in their view of findings, analysis of findings and reporting- a point that Johnson and Christensen (2010) have raised and explained in detail. Being an insider researcher as explained under subsection 3.3 is also commonly associated with being more subjective. Markee (2013) and Beals, Kidman and Funaki (2020) refer to the point that insider researchers are traditionally subjective too [-this is not to take away the point that subjectivity has its place and relevance in research (Mruck & Breuer, 2003)]. While this may be the case researcher biasness and unwanted subjectivity can still be minimised. In order to deal with researcher bias at all stages of this research, the researcher ensured reflexivity, as suggested in the literature such as by Anderson (2008) and Johnson and Christensen (2010). Reflexivity entails critical self-reflection and examination especially with regard to potential biases (Johnson &Christensen, 2010). It '…not only increases the creditability of the findings but also deepens our understanding of the work' (Dodgson, 2019, p.1052). As already highlighted above (subsections 1.7 and 3.3), potential biases could have been linked to the researcher's experiences and instructional interactions with the mathematics PSTs which in themselves had brought valuable insight to the PSTs experiences, but could also impact upon the researcher' interpretation of data for instance. Reflexivity entailed that researcher influence and experience was consciously scrutinised, evaluated and probed throughout the stages of the research. The researcher had to actively engage in constant questioning accompanied with critical attitude and reflection on the research

process and the research findings. This was further enhanced through dialogue with fellow Masters of Mathematics Education students, some PhD in Mathematics Education students, professional peers, research participants and engaging with the field notes reflectively too.

3.11.3 Low-inference descriptors

Low inference descriptors relates to recording 'verbatim accounts of what people say, rather than the researcher's reconstruction of the general sense of what a person said, which allow researchers' personal perspectives to influence the reporting'(Seale, 1999, p. 148). This dissertation has examples of what the participants actually said in response to the questions that were asked through the questionnaire and the interviews. It has also presented some literal citations or extracts from the documents that were reviewed. According to Ary et al. (2009) such have a way of facilitating understanding and strengthening the interpretations of the data.

3.12 Data Analysis

Qualitative data analysis approach was used to analyse the data collected through the questionnaire, interviews with the student teachers (and their lecturers), and document review. Qualitative data analysis basically involves segmenting data into parts and reassembling the parts into a coherent whole, carried out from the perspective of addressing the research questions and achieving the aim of the research (Boeije, 2010). In order to get through these basic processes, Sjöström and Dahlgren's (2002) seven key steps: familiarisation, compilation of answers from respondents, condensation or reduction, preliminary comparison or classification, naming of categories and contrastive comparison of categories were followed. This led to identification of emerging overarching 'themes' that related to the original questions and grouping the identified themes under categories and further into sub-categories in a way that the responses could easily be comprehended and usable in providing answers to the overall interrelated research questions for the study. Content analysis was also applied in the investigation of both the textual primary and secondary data collected (Appendix D and G) for this study. The content analysis processes generally represented by three main phases: preparation, organizing and reporting (Elo & Kyngäs, 2008; Bozkurt, Akgun-Ozbek, Yilmazel, Erdogdu, Ucar, Guler, ... & Aydin, 2015) basically coincided with the process already described above as drawn from Sjöström and Dahlgren's (2002). Themes were developed with an extension of actual appearance of particular words and phrases and their frequency in the collected data (see Appendix D and G). Thus the researcher used thematic and content analysis. This was done without using any computer based qualitative data analysis software

apart from Microsoft word which was used to create tables where need be to present the summary of the analysis and findings (for instance see Appendix F).

3.13 Ethical Considerations

To start with, ethical clearance was granted by the UNZA's Ethics committee and so was permission to collect data from the students at the concerned higher learning Institution. Informed consent, which is key to research, was also obtained from the research participants. Participants have a right to know about the research, the how and the extent of their involvement as well as how the data collected from them would be used and stored (Wood & Smith, 2015). Informed consent was sought from the research participants. They were informed that participation in the study was voluntary. This implied that they had a right to decline participation or stop participating in the study at any point in time. The researcher explained the purpose of the study to the research participants and assured them of confidentiality and anonymity both during and after the study. The real names were not used, but codes. Details on this have been under subsection 4.2.1.2 below. In addition, the researcher assured the participants that the data collected were only to be used for academic purposes. All the raw data and documents containing personally identifiable information (PII) were stored, and managed in strict compliance with ethical guidelines. The hardcopy or physical documents such as the signed consent forms, completed questionnaires were stored in a place only accessible only to the researcher.

3.14 Summary

This chapter has presented detailed information about the methodology for this qualitative study on student teachers' preparedness for continuing professional development. The study setting, research paradigm, research approach, research design, population, sample size, sampling techniques and data collection instruments have been accounted. Multiple data collection methods were used and the significant role played in providing in-depth information for this study explained. The chapter has also presented the steps that were taken to reduce the threats to the research's credibility and trustworthiness. The last section discusses the ethical considerations applied for the purpose of protecting the privacy and confidentiality of the research participants. The next chapter presents and discusses the findings of this study.

CHAPTER 4: PRESENTATION OF FINDINGS

4.1 Overview

The previous chapter discussed the methodology for the study. This chapter presents the findings of the study starting with an overview of the participants in the study and then a presentation of findings in relation to the research questions.

4.2 Overview of study participants

In this study, Pre-service secondary school Mathematics Teachers' preparedness for Continuing Professional Development was examined. The views of student teachers as key research participants and the Mathematics/Mathematics Education lecturers as key informants were obtained. Forty-six (46) secondary school mathematics student teachers participated in this study through responding to the questionnaire items. Fifteen (15) were interviewed. Two (2) lecturers participated in this study as key informants. As stated earlier, questionnaire, in-depth follow-up interviews and documents for review were used in data collection. The key informants did not complete any questionnaire but were only interviewed in order to obtain the needed data for the study**.** They also provided access to some of the relevant documents that were reviewed for this study.

4.2.1 Background information of student teachers

4.2.1.1 Gender of the student teachers

The distribution of the 46 student teachers who participated in the study by gender is shown in Table 1 below.

Table 1: Distribution of student teacher participants by gender

	Number	**Percentage (%)**
Male	37	80
Female	9	20
Total	46	100

Of the 46 secondary school mathematics student teachers who participated in this study, 37 (80%) were male and 9(20%) female. This indicates that the majority of the student teachers

taking mathematics in their fourth year of study were male. Females were underrepresented among this group of students (taking Mathematics as their major subject of specialisation).

4.2.1.2 Subject combinations for the student teacher study participants

The subject combination or areas of specialization for the student teachers who participated in the study is presented in Table 2 below.

Table 2: Subject combinations for the student teacher study participants

Subject Combination(Major/Minor)	**Nº of student teachers per subject combination**	**Percentage (%)**
MAT/ PES	16	35
MAT/GEO	11	24
MAT/HIS	9	20
MAT/CHE	6	12
MAT/PHY	4	9
Total	**46**	**100**

The PSTs in this study were all taking Mathematics as their major subject of specialisation with a minor being Physical Education Studies or Geography or History or Chemistry or Physics. Table 2, above gives details of how many PSTs for each subject combination.

The real names of the participants were not used. The identification of the respondents and participants were coded as follows: Pre-service Student Teachers, PST was used and if data was from a questionnaire then the letters PST were followed by 'Q' (for questionnaire) and a figure to represent the questionnaire number. For instance, PSTQ10 represented data obtained from a preservice student teacher who completed a questionnaire which was numbered 10. On the other hand, if data was obtained through interviews, then this was represented by the letters PST followed by 'I' (for interview) and a figure to represent the position of the interview or interview number. Therefore, PSTI10 represented data obtained from a preservice teacher who was the 10th to be interviewed.

Lecturers, the letter 'L' was used to represent a lecturer. Where there was letter L this was followed by 'I' and a figure 1 or 2 since only two lecturers participated in this study. For instance, LI1 represented data obtained from a Lecturer who was the first one to be interviewed. The codes are bold as a way of helping to clearly distinguish between letters and numbers especially I(interviews) and 1 (one).

4.3. PSTs' conceptions of CPD

The mathematics preservice student teachers were asked about their conceptions of CPD. In their responses, as presented through the questionnaire and interviews the student teachers shared their understanding and interpretation of continuing professional development. Different views were shared about what it was. An analysis of their responses led to the following themes and categorisation of the conceptualisation and understanding of CPD: CPD as lifelong learning, CPD as meetings, CPD as upgrading one's qualifications and CPD as a programme mandate for teachers. The PSTs' responses in relation to each one of these categories are presented below.

4.3.1 CPD as Lifelong learning

In an attempt to share their understanding of CPD majority of the PSTs in this study indicated that lifelong learning was what CPD was all about. For instance, **PST15** stated that: *'lifelong learning is learning throughout the same thing as CPD. It is a process of getting knowledge as you are working picking up from the teacher training days…'*

In the same line, **PSTI1** stated that:
'It is a learning process, over a very long period of time, to develop or grow…that is why it is also called continuing development.'

Yet **PSTQ2** wrote: *'it is a process of continuous learning and acquiring knowledge and skills about specific difficult topics in mathematics'*. A point which in some way contradicted what lecturer I1 stated concerning the focus of CPD as designed to be presented to students taking Mathematics:

> '*…of course we tell them that they can look at topics that are difficult to teach as part of CPD, but that is not all…there are other things that can be discussed including assessment in mathematics, problem solving among others…what is key for them to be able to identify what it is they need to focus their attention on…'* **LI1**.

Despite this being said, the course outlines shared by the same lecturer did not show such details (See Appendix F).

PSTI10 emphasised that *'you can't put a time on learning…it is like forever. That is why it is lifelong learning… and you have to hopefully keep getting better at teaching mathematics'*

PSTI11 expressed that *'…it is the development of the professional self of a person by continually learning that is why it called continuing **professional** [with emphasis] development'*. From the above comments it can be concluded that the PSTs were of the view that CPD is a learning process for the purpose of improvement.

4.3.2 CPD as meetings

PSTs' understanding of CPD was linked to meetings or meeting attendance. Representative of this view are the following comments from the PSTs: **PSTI9** stated that '… CPD *is when you have meetings…meetings like departmental meeting…'*. This was more like building on the argument written on questionnaire *by* **PSTQ44** that *'…this is the meeting which is conducted by the department to present work'*.

In the same line, **PSTI3** stated that: *'you know you are learning when you attend meetings such as the Lesson Study meetings…because there you learn how to prepare and teach the difficult Maths topics…'*

4.3.3 CPD as upgrading one's qualifications

Some PSTs who participated in this study indicated that CPD was about upgrading or furthering one's academic studies and hence qualifications. Excerpts from the questionnaire and interviews include the following:
'It is about continuing learning for one to get the highest qualification there is …for instance from degree to masters' level…' expressed **PSTI6**.

'This is where teachers of mathematics continue to further their studies to gain more knowledge for the benefit of the learners they teach' indicated **PSTQ11**.

Other PSTs expressed their concerns by stating that they are not ready for CPD because of this. For instance, **PSTI2**'s argument was that *'I cannot do CPD… I don't see myself going for further studies after completing this degree programme…that is why I am saying CPD is not my thing…'* Such concerns appear to have been echoed by **LI2** who mentioned that *'…masters or PhD programmes are something our students generally do not aspire to pursue…meaning that learning for them ends with this first degree programme…'*

A view such as this may be said to accommodate only one form of formal CPD activities (subsection 2.2.3.1 above) that is upgrading one's academic qualification among all others. It not only leaves out other forms of CPD activities that are considered form, but also informal

CPD activities (subsection 2.2.3.2) that can also contribute to professional development to one's disadvantage. As already explained and illustrated above under subsection 2.2.3.1 and 2.2.3.2. both formal and informal CPD activities can contribute to development.

4.3.4 CPD as a programme mandate for teachers

PSTs responses during interviews and as shared through the completed questionnaire referred to the point that CPD was a government programme that teachers were mandated to fulfil. They viewed CPD as a directive from government, through the Teaching Council of Zambia (TCZ) and teachers needed to comply if they were to keep their teaching jobs. Excerpts representative of this view are presented below.

PSTQ9 indicated *'It is a government programme for teachers, in the mathematics department, which has the objective of uplifting and expanding knowledge among teachers…for particular topics which are challenging.'*

PSTQ29 also stated that *'They are programmes that are considered very important for teachers so that they continue to handle mathematics professionally…otherwise they will find themselves with no job'*

PSTI13 *said '… it is what the Teaching Council of Zambia expects from teachers…a programme for teachers so that they make points… that the Teaching Council counts and considers when looking at the future of a teacher and his or her teaching work…'*

PSTs' point is somehow in line with TCZ expectation. TCZ has indicated an award of CPD credit points to teachers as one way of encouraging them to direct their attention to and draw on the benefits of CPD (TCZ, unpublished). The argument is established. The rationale and value for CPD has been presented under subsection 2.2.2 above where it is highlighted that CPD can be a way through which governments direct teachers to national priorities including those in education related.

4.4 PSTs perception of how they were prepared for CPD

The mathematics student teachers were asked about how they were prepared for CPD. An analysis of PSTs' responses led to the following themes emerging: School Teaching Practice (STP), Peer teaching, and Lectures and personal study as ways through which they were (being) prepared for CPD. Sample responses in each case are presented below.

4.4.1 School Teaching Practice (STP)

STP was the most commonly mentioned way through which the PSTs indicated they were prepared for CPD. Examples of comments raised with respect to STP being a way through which the PSTs were being prepared are:

'…I did a lot of CPD during STP… we were having lesson study…to learn about the difficult topics…' **PSTQ15**

'...that is where CPD is-in the schools. I observed and experienced it there…we used to meet as a department' **PSTI11**

'I attended all the meetings that were called in the department…' **PSTQ44**

We were meeting to discussing the lessons…' **PSTI5**

'I had a mentor teacher during School experience…I was guided in my teaching work by him. I learnt a lot about the teaching mathematics.' **PSTQ55**

STP (and mainly through Lesson Study) was the most commonly mentioned way through which the PSTs were being prepared for CPD because all the PSTs who participated in this study had gone through it.

Lesson study is the most mentioned CPD initiative. It is the main SBCPD activity as evidenced in the government documents that list the CPD activities that teachers can ideally consider. These documents are the Framework for SBCPD through LS and the CPD Framework for teachers in Zambia which was still in draft form and unpublished. The Framework for SBCPD through LS emphasizes that '… there is need to practice lesson study for in-service teachers' (MOE, 2009, p.7).

4.4.2 Peer teaching

The PSTs in this study indicated that peer teaching was one of the ways through which they had been partly prepared for CPD. Examples of what they stated include the following:

'We did peer teaching teaching…I was nervous and didn't really want to do it…but it is compulsory. I ended up doing it and …I learnt a lot from my course-mates and the lecturer who was with us. Something we continued doing when on STP, but at that time learning from the already practising teachers and the HOD…' **PSTI13**

'Peer teaching is something like preparation for Lesson study …the part where one presents the lesson and others make comments on the lesson taught…' **PSTQ60**

Their constructed argument was that they were exposed to receiving feedback on their teaching from their peers and from their lectures and that it was helpful in cases. It is probably based on such experience and exposure that **PSTI10** stated that:

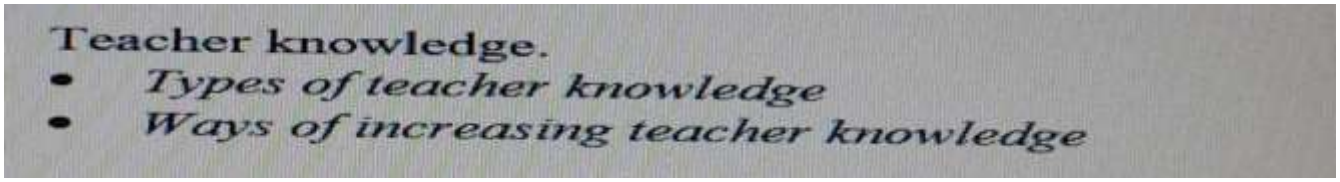
'It felt like I was being criticised by other and being judged by my lecturer…but at the end of the day I was learning, knowing better and becoming better…' **PSTI10**

There was an acknowledgement of the crucial role of peer teaching in preparing them for their future professional teaching roles.

4.4.3 Lecturers

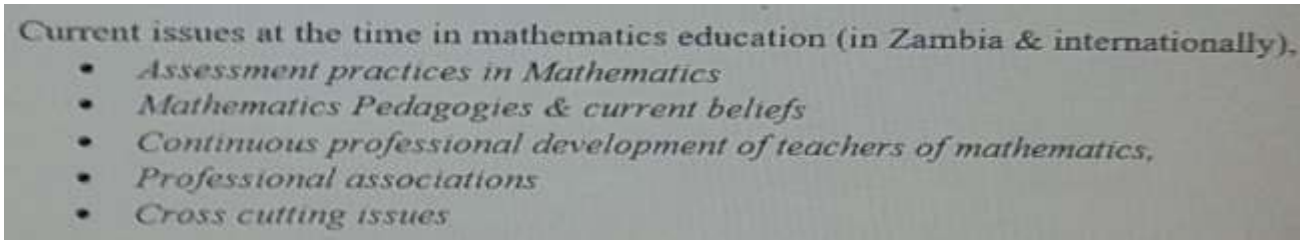
Lecturers were mentioned as a means through which the PSTs indicated they were prepared for CPD. **PSTQ56** indicated that: *'…lecturers are there to teach us about such things of CPD…'* In addition, **PSTI12** stated that *'…our lecturers should be demonstrating CPD things…they are our role models…'* **PSTQ67** also indicated that *'our lecturers are to teach us everything CPD…not just in theory but practically…'* **LI1** confirmed this, but also state that *'we do our part as lecturers to teach…but you know how our students are…they learn for the exams and not necessarily to apply in their real life situation'*. The roles of the lecturers both as teachers and as role models was raised and emphasised.

Lecturers are guided in their teaching by the course outline. The Mathematics Course Outlines for the Mathematics content courses (Appendix J) did not reflect any CPD content but the Mathematics Methodology-related course (Appendix K) did reflect some CPD-related content. Below is an extract of CPD-related content from the third year Mathematics Methodology-related course for the PSTs.


Teacher knowledge.
- *Types of teacher knowledge*
- *Ways of increasing teacher knowledge*

Source: MAT 330 Course Outline, 2022, p.3

An extract from the of CPD-related content from the fourth year Mathematics Methodology-related course for the PSTs is below.



Source: MAT 430 Course Outline, 2022, p.2

Lecturer **LI1** in commenting on parts of the course outline content shared and coverage mentioned that the '*we teach as guided by the course outline and of course make sure we explain what needs to be explained to students as clear as possible…'*

4.4.4 Personal study

Comparably, very few PSTs made reference to personal study or self-study or self - directed study/reading as a way through which they had been prepared for CPD. This presented a reflection of their context. Among the few comments made by the PSTs through the questionnaire and interviews include:

May be I can read too to help myself have more knowledge about teaching Mathematics…the only problem is time to do it because of all the other things I have to do as a student…' **PSTI20**

'I think reading different kinds of mathematics material or even just education material can or has helped…' **PSTQ50**

'When you read you can actually be better at many things like your knowledge increases, but I am not very sure if the reading part is CPD …' **PSTI14**

'I know that reading… reading books, is also important for a teacher, but come to think of they it don't examine you on it that is why I don't pay much attention to it… there is really no point…' **PSTI13**

Lecturer **LI2**'s comment on PSTs and personal study with respect to CPD was that *'...I doubt our students can do this…finding time to study or read on their own on stuff that is not or may not be directly examined can be a challenge... the reading culture is generally poor. Motivation for such is generally internal and that is what our students don't have… '*

The above suggests that, from the PSTs' perspective, even though personal study involving reading subject related or education and professional related literature stimulates learning and is potentially important in promoting, it is not readily recognised as CPD.

As stated above, research question 2 was concerned with determining the perception of mathematics PST on how they were prepared/being prepared for CPD. The PSTs indicated that this was done through STP, peer teaching, lecturers and personal or self-study.

4.5 PSTs perceptions regarding the way(s) they were prepared for CPD

Research Question 3 sought to find out the PSTs perceptions regarding the way(s) by which they were prepared for CPD. Their perceptions were revealed in the completed questionnaire as well as the follow up interviews and they have been put into two categories; not prepared for CPD and prepared for CPD.

4.5.1 Not prepared for CPD

Majority of PSTs indicated that they did not think they had been prepared for CPD.
Comments representative of this view included:

'I don't feel prepared for it…I had no confidence even when on STP and I didn't feel and I don't still feel confident…' **PSTQ44**

'…Our lecturers did not emphasise about CPD…may be there should be a way they could be telling us what is being taught just for the sake of getting a degree and what we must know for applying' **PSTI8**

'When they come to observe you, it feels like they just want to find faults, mistakes that you are making… and use that against you or to fail you…' **PSTI13**

'…some things are examined, there are also others were once you do it that is it…like peer teaching…you do it and forget… and start to prepare for the exams…' **PSTI20**

'Not sure about CPD…Most of the content we cover in mathematics is hard and not easily applicable and we end up focusing more on the hard content more for fear of failing the exams than on content in methodology…' **PSTQ43**

'A lot of what we cover in maths is bookish…this somehow affects the way we handle the maths work in methodology. We end up just memorising instead of reflecting, understanding and even applying…' **PSTI3**

'I could have learnt about it in especially in methodology courses, but the thing is there are too many things to learn there…I probably didn't pay much attention to it and the lecturers did

not consider much about whether we understood it and its importance in my future practice.' **PSTI15**

As if in response to the PSTs comments one lecturer stated that: *'we do our part as lecturers to teach…but you know how our students are…they learn for the exams and not necessarily to apply in their real life situations.'* **LI1**

4.5.2 Prepared for CPD

For the few that indicated they were (well/adequately) prepared for CPD their responses mainly related to the ways by which they were prepared and already indicated above under subsection 4.4.2 that is through: STP, peer teaching, lecturers and personal/individual study. For some it was with reference to a single way through which they had been prepared such as;

'... we were having lesson study during STP…to learn about the difficult topics…I am ready for CPD' **PSTQ15**

An example of what was said during interviews was: *'peer teaching exposed me to continue learning…'* **PSTI1**

While some mentioned a single way through which they considered to have been prepared for CPD while for others it was a combination of the different ways such as mentioned above. For instance, **PSTI12** shared that:

'I learnt some things during my peer teaching session and this is in addition to what some of my lecturers had taught and demonstrated…I think I am alright with CPD things'

PSTI11stated that:

'…we used to meet as a department to help each other with topics we were struggling with… I would also read up stuff related to mathematics, teaching mathematics…'

In some cases, some PSTs stated the current shortcomings of what was being done/had been done to prepare them for CPD and also in others suggesting what they thought could enhance their preparation for CPD. For instance, with respect to STP **PSTI15** shared that:

'Lesson Study was not emphasised here at university. It was in the school …it was good to look at how to teach difficult topics, but it wasn't what people like me really needed at the time…'

Examples of what was shared by PSTs as concerns with respect to peer teaching for instance, were:

'I learnt some things during my peer teaching session …the only problem is that this practical teaching activity is only done once …I wish they could give us chance to teach two or three times to see whether and how we are applying what we have been learning through the feedback they would give us…' **PSTI4**

'When they come to observe you, it feels like they just want to find faults, mistakes that you are making… and use that against you or to fail you…' **PSTI2**

'…fear, anxiety…you are not taken through how to manage such' **PSTQ60**

Some PSTs stated the following with regard to their lecturers being one way through which they were/had been prepared for CPD:

'Emphasising the importance of CPD to us and helping us see the link between what we are being taught and what is happening practically on the ground in relation to CPD …can help us a lot…' **PSTQ16**

'… our lecturers should also model these things of CPD…' **PSTQ3**

4.6. Summary

This chapter has presented the findings of the study starting with an overview of the participants in the study. The findings have been presented following the research questions. Based on research question 1, the mathematics preservice student teachers were asked about their conceptions of CPD. Their responses are captured under the themes: CPD as lifelong learning, CPD as meetings, CPD as upgrading one's qualifications and CPD as a programme mandate for teachers. Research question 2 was about how the PSTs were prepared for CPD. An analysis of PSTs' responses led to the following themes emerging: School Teaching Practice (STP), Peer teaching, and Lectures and personal study as ways through which they were (being) prepared for CPD. The last research question sought to find out the PSTs perceptions regarding the way(s) by which they were prepared for CPD. Their perceptions were put into two categories; not prepared for CPD and prepared for CPD. The next chapter discusses the findings.

CHAPTER 5: DISCUSSION OF FINDINGS

5.1 Overview

The previous chapter presented the findings of this study on Secondary Mathematics Pre-service Teachers' preparedness for Continuing Professional Development. This chapter discusses the findings. The findings of this study are discussed through the use of related literature, some of which is already presented in chapter two, research questions and the theoretical framework

5.2 PSTs' conceptions of CPD

5.2.1 CPD as lifelong learning

In an attempt to share their understanding of CPD majority of the PSTs in this study indicated that lifelong learning was what CPD was all about. As Already stated above 'Continuing professional development (CPD) is a substantial…component of lifelong learning… 'Friedman (2023, p. 588). Therefore, it can be concluded from the PSTs' responses that they were of the view that CPD is a learning process and one for the purpose of improvement even though specific reference to different stages of one's (career) life was not explicitly stated. Teachers are expected to continue learning, after their initial education, throughout their career years, so as to improve their practise and be able to adapt to the changing (learning) needs of their society and learners (Day & Sachs, 2004; de Vries, Jansen, & van de Grift, 2013).

It can also be deduced from the views shared by the PSTs that the focus of CPD is basically limited to gaining knowledge and developing skills for the teaching of the topics in secondary Mathematics syllabus that are deemed to be difficult to teach. Even though they considered CPD as learning, their focus was mainly learning as related to acquiring technical mathematics content knowledge and teaching skills and little or no focus on considering knowledge and skills pertaining to personal development. A point similar to the one raised with reference to already serving teachers as presented in Sinyangwe (2017). With reference to the argument that Mathematics is generally a difficult subject to learn/teach and that learner performance in national examinations in the subject in Zambia has been extremely low (Examinations Council of Zambia, 2012; 2015; 2016; 2018, 2022; Mukuka et al., 2019) it may be justified that focus of CPD be on gaining knowledge of and skills for teaching difficult topics in mathematics to contribute to improved learner performance. This specific focus however appears to ignore

other aspects of teaching and appears detach the development of a personal component of a professional. As argued by Young (2015) there may be need of bringing in the word 'personal' in CPD to have Continuing Personal and Professional development (CPPD) or of approaching CPD as CPPD (without necessarily having two Ps) where there is among other things the reflection of personal responsibility for one's professional growth and or where focus of CPD initiatives one engages in can be on personal matters which may be directly or indirectly related to one's profession. CPD should aim to develop the individual specialist and their profession (Cole, 2000) too.

5.2.2 CPD as meetings

Some PSTs' understanding of CPD was linked to meetings or meeting attendance. Their understanding of CPD was linked and limited to a specific kind of event- a meeting. While there is evidence that attendance of meetings such as mentioned by the PSTs can support PD (Mamba, 2022) CPD, goes beyond meetings or meeting attendance. Works such as Day (1999) do align with this point when he indicates that CPD goes beyond attendance of a CPD activity. It is not necessarily an event itself, but a process. This view is also advanced by Singh, Rind and Sabur (2021) who state that CPD is a process that supports teachers and their development. Therefore, suggesting that attendance of meetings such as Mathematics Department meetings or Lesson Study meetings, as cited by the PSTs, provide opportunities or are avenues through which teachers can continue to learn and hence develop. They are ways that can facilitate teachers' personal and professional learning and development (Mahmoudi & Özkan, 2015; Mansour et al., 2014).

The PSTs' views of CPD are probably based on their context and experiences such as experience of School Teaching Practise (STP). However, if focus is on CPD being meetings or attendance of meetings, then it shifts attention from what is considered as holistic picture of PD as presented by Day (1994) and discussed above under subsection 2.2.1 above.

5.2.3 CPD as upgrading one's qualifications

Some PSTs who participated in this study indicated that CPD was about upgrading or furthering one's academic studies and hence qualifications. A view such as this one held by PSTs not only leaves out other forms of CPD activities that are considered formal, but also informal CPD activities (subsection 2.2.3.2) and which that can also contribute to professional development to one's disadvantage. As already explained and illustrated above under

subsection 2.2.3.1 and 2.2.3.2. both formal and informal CPD activities can contribute to development. Srinivasacharlu (2019) further argues that CPD involves divergent formal and informal activities which *'…aim at developing the teacher's… intellectual abilities (cognitive domain), self-confidence, attitude, values, and interest (affective domain) and skills and competencies (psychomotor domain) for improving personality and to carry out the responsibilities of the teaching profession properly…*' (p.29). Similar ideas also expounded by Hayes (2016). This further stretches the argument of the focus of CPD being broad as well contributes to supporting the ideas of embracing divergent informal and formal activities that support teachers' development.

5.2.4 CPD as a programme mandate for teachers.

PSTs responses during interviews and as shared through the completed questionnaire referred to the point that CPD was a government programme that teachers were mandated to fulfil. This view of CPD is somehow in line with TCZ and hence government expectation for teachers. The rationale and value for CPD has been presented under subsection 2.2.2 above. One of the rationale for it being that it (CPD) can be a way through which governments direct teachers to national priorities including those in education related. Indeed, changes and innovations in the education sector can be successfully implemented, if teachers are prepared for them-something that could be achieved through targeted CPD initiatives. CPD can also be a means of equipping teachers to be well-informed critics of national education policy reforms or initiatives (Bolam & McMahon, 2004)- a point that needs to be considered during initial teacher training and preparation too. However, this does not mean that CPD should only be viewed as a directive or mandatory programme by government (through TCZ in this case). Personal motivation for achievement and growth (McMillan, McConnell & O'Sullivan, 2016) should apply too. Their general argument being that motivation factors for CPD as expressed by teachers themselves and for themselves need to be considered as well.

Summary of discussion of PSTs conception of CPD

The following has been presented as a way of bringing together and summarising the discussion of PSTs conception of CPD presented above. From a constructivist perspective, knowledge is constructed. Each individual constructs his/her own reality or meaning and as such there are multiple interpretations of the same reality. Each PSTs had an opportunity and seized it to construct their own reality as it related to the conception of CPD. It is evident that the PSTs' conception of CPD is divergent and linked to their personal experiences aligning with

constructivism principles too. This could be because of their experiences of it during their STP during or observations made among other factors. On one hand, despite there being variations in PSTs' conception of CPD, their responses show that they have some appropriate ideas about the concept of CPD, its focus and value.

On the other hand, the PSTs conceptualisation of CPD as shown in the themes presented above also suggest some element of ambiguity attached to the term CPD itself. This aligns with points by researchers such as Friedman and Phillips (2004, p.361) who state that there '…is confusion regarding its definition and purpose in both academic and professional literature which extends to professionals themselves…' and argue that CPD is an ambiguous concept. Their suggestion in conclusion is that 'clarifying the definition(s) and purposes of CPD and linking it more closely with the ideals of professionalism' (Friedman & Phillips, 2004, p.361) with the '…underlying conceptions of professionalism… made explicit' (Kennedy, 2007, p.95) is a must. While Friedman and Phillips (2004) were not referring to student teachers' conceptualization of CPD as this study is, their suggestion may need to be critically considered with respect to preparation of Mathematics PSTs, in this context, for CPD.

In addition to there being some element of ambiguity attached to the term CPD itself, the PSTs' responses also show that their conceptualization of CPD is narrow. Their perception and description of CPD presents to be limited and limiting at the same time. For instance, to start with, even though there is some acknowledgement of CPD being about continuing learning, the PSTs' conceptualisation of the focus/content of CPD appears to be limited to gaining knowledge and developing skills for the teaching of the topics in Mathematics that are deemed difficult to teach as presented by an expert such as the HOD and or an in-service teacher. Even though they considered CPD as learning, their focus was mainly learning as related to acquiring technical mathematics knowledge and teaching skills for the said difficult topics to teach and not extended to other areas. Discussing the difficult-to-teach topics in Mathematics is particularly important, but the focus of CPD can be extended. For instance, it could include knowledge and skills for supporting mathematics learners' sustained motivation and engagement, a focus on knowledge and skills pertaining to one's own personal development among others such as suggested by Srinivasacharlu (2019) and CDC (2013) with details already shared under subsection 5.2.3 and 2.2.1 respectively too.

Further, even though there is some acknowledgement of CPD being about continuing learning, the PSTs' conceptualisation of the avenue for learning was limited. It was largely linked to

Lesson Study, the most common school based CPD (SBCPD) in Zambia, and university learning were one's academic qualifications could be upgraded. While these are certainly means through which one can continue to learn and develop, there are others worth considering too. There are several other ways and means: collaborative and non-collaborative, school-based or non-school based, formal or informal, planned or incidental means through which teachers of mathematics can continue to learn.

As advanced by the sociocultural framework, it is evident that the PSTs context-at university or school they did their STP at- had an influence on their conception of CPD. It is maintained that having an understanding of how PSTs conceptualise CPD can have implications on Mathematics teacher training practices. For instance, it can help assess what and how much they know about CPD during their teacher training period. It could also give an idea of how prepared they could be to participate in and demonstrate commitment to CPD and lifelong learning. Having an understanding of the meaning that the PSTs attach to CPD can therefore inform review of the PSTs course content and implementation strategies as a way to facilitate correcting CPD misconceptions or misinformation where evident and adequately preparing the PSTs to commit to CPD. Lecturers' and already serving teachers'(who are mentors of PSTs in schools where PSTs do their STP) use of and reference to the finalised and published version CPD framework for teachers in Zambia document could guide in providing such comprehensive and holistic knowledge and exposure in context too.

5.3 PSTs perception of how they were prepared for CPD

5.3.1 School Teaching Practice (STP)

STP was the most commonly mentioned and dominant way through which the PSTs indicated they were prepared for CPD. There is a possibility that STP was the most commonly mentioned way through which the PSTs were being prepared for CPD because all the PSTs who participated in this study had gone through and experienced it. The schools the PSTs were attached to as part of STP were all not the same, but what was presented as experienced with respect to CPD appear similar. STP, also known as school teaching experience or teaching experience or school experience or practicum in some instances is a compulsory and practical component of the teacher education programme. It is considered as an orientation into the teaching profession (Gray et al., 2017). STP plays an influential role in helping PSTs acquire apply their acquired teaching knowledge and skills and further develop them and the needed

professional knowledge, values and ethics. It is generally designed to provide opportunities for the PSTs to engage in for their professional development. As already mentioned above under subsection 2.2.3.1.2 School-Based CPD is encouraged and supported in the Zambian context. According to MOE (2009), SBCPD is considered as *'...one of the effective ways of improving education as far as teaching is concerned as it targets self development, group and eventually institutional development'* (p. iii). As already presented under subsection 2.2.2.1.2 above Lesson Study (LS) and Departmental meetings including mentorship are examples of school based activities that can support teachers' professional growth. PSTs' point on engaging in CPD activities there in the schools was in line with Ministry of Education/expectation of teachers therein. What was presenting to be limiting for the PSTs in this study is the focus of this SBCPD activities they engaged in. The student teachers consistently indicated that they discussed the topics that were considered difficult to teach. The focus of CPD for teachers in this case and with reference to what has been discussed above such as under subsection 4.2.1 should go beyond this. The Zambian Curriculum Framework itself does give an idea of what it can extend to when it states that CPD *'...helps in updating pedagogical approaches, pastoral care for learners, assessment procedures, school organization and management, and relationship with parents/guardians and the community* (MOE, 2013 p. 60). It is argued that PSTs need to be exposed to much more than they are currently exposed to when on their STP and this being with respect to CPD activities and CPD focus.

Another angle to this argument relates to the STP Observation instrument (See Appendix I) used. An analysis of the instrument presents that it is relatively difficult to conceive CPD initiatives that the PSTs engage in. Which may imply that it is not one of the areas that is particularly 'assessed' or considered as being critical for PSTs by the lecturers observing the PST. Additionally, it is challenging to consider how and to what extent CPD initiatives which the PSTs engaged in contributed to enhancing PSTs' creativity, reflective and reasoning abilities as well sound mindedness in judgement making especially in cases of uncertainty-aspects of which are to demonstrate teacher learning and development.

5.3.2 Peer teaching

The PSTs in this study indicated that peer teaching was one of the ways through which they had been partly prepared for CPD. Peer teaching or micro teaching is 'a common practical exercise in teacher education …'(Manchishi & Mwanza, 2019, p.88) and is viewed as a

'…professional development tool that gives pre-service teachers a chance to strengthen their teaching skills (Mukuka & Alex, 2023, p. 1). It is considered as a form of cooperative learning where one student teacher (peer teacher) teaches fellow student teachers (peer learners and observers) an assigned topic or subtopic under the supervision of the lecturer (teacher educator) (Abdelkarim, Ra'ed, Abuiyada, 2016). Its' benefits include: sharpened ability to identify one's weaknesses and strengths in teaching; sustained and deeper reflection abilities; enhanced critical thinking; improved teaching skills and motivation to learn; knowledge acquisition and skills development (including lesson evaluation, time management) through the interaction (Murphy Odo, 2023; Manchishi & Mwanza, 2019: Ralph, 2014; Rohrbeck et al., 2003). The common complaint registered by the PSTs though was that they were not given chance to correct the mistakes that would have been made in their first attempt at peer teaching. This could be due to time constraints. Peer teaching '… activities require more time, more supervisors, and more resources to function at its maximum capacity' suggests Mukuka and Alex (2023, p. 1). It could be for this reason that one lecturer indicated that it had been resolved in the department that the third year methodology course content be split in two parts with one part to be undertaken at second year so as to create more time for it.

Reference to the peer teaching observation instrument (see Appendix G) indicates that different aspects of teaching other than possession of mathematics content knowledge were considered during the whole peer teaching process. It went beyond checking for correctness in mathematics content/information being delivered and the mathematical language used. However, as was argued in the case of the STP instrument, it also demonstrated that there was little evidence of for fostering expertise or skills related to reflection as well as feedback receiving, handling and usage.

5.3.3 Lecturers

Lecturers were mentioned as a means through which the PSTs indicated they were prepared for CPD. Teacher education institutions have a responsibility to prepare student teachers for their own learning and teaching responsibilities (Sandholtz, 2011). Lecturers, therefore, have a significant role to play in delivering information or content relevant to student teachers preparation for the work world and for life. CPD-related content is no exception. Lecturers are guided in their teaching by the course outline. The Mathematics Course Outlines for the Mathematics content courses (Appendix J) did not reflect any CPD content but the Mathematics Methodology-related course (Appendix K) did reflect some CPD-related content.

It, however, did not provide the details or extent of coverage. The PSTs' note books that were availed showed summarised and generally not easy to make sense of points (See Appendix K) that the students had written about what CPD was.

One lecturer's response in relation to this was that the students were given all the relevant information about CPD, but that they probably did not write everything down in their note books. Reference to a test paper (see Appendix M) did present that questions on CPD were beyond what CPD was and therefore suggesting more could have been covered during lectures than the PSTs actually revealed. However, no answer script was availed to allow for further analysis of whether the PSTs answered the questions or not and how well they performed if they answered the question.

The PSTs indicated that lecturers are (to be) role models. Lecturers' role modelling role can relate to the actual CPD content they teach, but it also extends to cultivation of a mind-set for knowledge acquisition. It further extends to how they teach CPD- related content and how they practice it. Teaching the CPD content, as reflecting in the course/programme outline, can raise awareness and thus increase knowledge of or about CPD and contribute to the development of a mind-set for knowledge acquisition. However, how this is done also matters. The PSTs may need opportunities to actually practice these skills in their learning environment. As already presented under 2.2.4 there are training approaches or strategies or methods for promoting knowledge and skills to create a solid foundation for professional development in literature. An example given is that by Spilková, (2001) who presents that incorporation of various forms of reflective practices in the teaching as well as assessment of student teachers is crucial for preparing student teachers for PD. To this effect Wray (2007) presents the use of Teaching Portfolios among PSTs, Ulvik (2014) presents Action Research and Ooi (2021) as well as Nash et al (2017) CPD plans. The argument is that although some of the knowledge and skills for PD can be presented in coursework/course content, the PSTs may need opportunities to actually practice these skills in their learning environment. The forms of reflective practices and extent to such reflective practices are actually incorporated in the preparation of PSTs for CPD may vary depend on context among other factors. To elaborate, the Mathematics Methodology- related course showed that PSTs were expected to carry out a research study. However, PSTs responses did not reflect that they considered research as a way through which they were being prepared for CPD. In fact, whenever research was referred to in the interviews, for instance, majority indicated that they did not see research as helpful for their learning and considered it as a preserve of postgraduate students or studies. It is

concluded that it is not only a coverage of CPD content that lecturers deliver that would work to prepare the student teachers for CPD, but also consideration of how PSTs perspectives and mind-sets toward CPD could be made more positive. Mind-set is one of the key drivers toward an individual successfully accomplishing academic and professional tasks (Makhluf, 2020). The mind-set of the lecturers toward learning and CPD is as important as the mind-set of the PSTs. It is also concluded that the development of a positive mind-set toward CPD should go hand in hand with development of key competences for lifelong learning and professional development (Karakuyu (2023); Pilli, Sönmezler & Göktan, 2017; Jovanova-Mitkovska, & Hristovska, 2011 and; Sahin, Akbasli & Yelken, 2010) in context. These can act as foundation for continuing learning.

PSTs' views shared in this study about lecturers being role models can be said to be in line with literature such as by Izadinia (2012), Timmerman's (2009) as well as Lunenberg, Korthagen and Swennen (2007) who also maintain that teacher educators are role models. Teacher educators' role as role models can impact on student teachers view of teaching, of learning and continuing learning. Jack, Hamshire and chambers, (2017) argue that role modelling is considered as an effective way of supporting students' learning. They argue that being exposed to positive role models can be beneficial to students learning and exposure to negative role models provides students with opportunities to (re)consider the kind of professional they aspired to be. Though in the case of undergraduate nurse education, their arguments can be extended to teacher education too. It is a crucial way of supporting learning but a role which is often neglected argued Lunenberg et al (2007). This neglect could be as result of several factors among them being too busy as indicated by lecturers in this study.

Lecturer **LI1** stated that *'we appreciate that we are our students' role models …it is just that there are so many things like time constraints…that can also hinder our participating in CPD and being the positive models for them in this regard…'*. Scholars such as King (2004) and Adu and Okeke (2014) acknowledge this when they state that lecturers' participation in CPD can be affected or hindered by several factors. This can make them negative role models. Jack et al (2017) advance that exposing students to perceived poor practices can have adverse effects on their learning and can lead to development and sustaining of negative feelings about their work. It could be for such reasons that Adu and Okeke (2014) argue that addressing such inhibiting factors could contribute to their active participation in CPD. 'CPD needs to be considered as a normal part of professional life…' (King, 2004).

While it is acknowledged that addressing factors inhibiting lecturers' participation in CPD would facilitate their being positive role model for students, it is argued here that the need for CPD to be self -directed and for students to be self-motivated to engage in CPD needs to be inculcated in the students too. It could be for this reason that the ZECF also state that *'Learning institutions should develop in teachers… the spirit of Continuing Professional Development …'* (CDC, 2013, p.60). The PSTs can be intrinsically motivated to engage in CPD. Self-directedness in CPD matters and intrinsic motivation can be stimulated in specific contexts. Suggestions by researchers such as by Mushayikwa and Lubben (2009) in disadvantaged communities in Zimbabwe may need to be considered and explored for possible adoption or adaptation in the Zambian context.

5.3.4 Personal study

Comparably, very few PSTs made reference to personal study or self-study or self - directed study/reading as a way through which they had been prepared for CPD. Personal study involving reading subject related or education and professional related literature stimulates learning and is potentially important in promoting professional development. However, it being a form of CPD or its' role and value in promoting professional development was not readily recognised by the PSTs in this study. The lecturer's comment on PSTs' lack of commitment and motivation to personal/self-study/reading presents to be consistent with reports on Zambians' reading culture. The reading culture in Zambia among school-going pupils, adults and professionals is reportedly poor (Kafusha, Mwelwa, Mkandawire & Daka, 2021). It is concluded that individual preference and or combination of other factors among them poor reading culture, lack of access to relevant reading resources, time constraints and general lack of intrinsic motivation are among the factors that affect the uptake of this form of CPD or the PSTs consideration of it as a means through which they could be prepared for CPD.

Summary of discussion of PSTs' perception of how they were prepared for CPD

The following is presented as a way of merging the discussion points relating to PSTs' perception of how they were prepared for CPD. It is evident from the findings presented in chapter 4 under subsection 4.4 and the discussion here that the PSTs actively constructed their knowledge on CPD and how they were being prepared for CPD. This is in line with constructivism principles. Their responses show that STP was the dominant way through which PSTs perceived they were prepared for CPD. This suggests that there is need for teacher training institutions and schools, where STP is done, to work closely to ensure PSTs are

exposed to much more than they are currently exposed to when on their STP especially with respect to varied CPD activities and CPD focus. This would be to allow for acquisition of holistic foundational knowledge of continuing learning and of themselves as learners, varied learning skills and strategies and positive values for embracing lifelong learning. It would also allow for assessment and ascertaining PSTs engagement and commitment to CPD during STP.

Additionally, the PSTs' responses showed that in addition to STP, there were other ways too: peer teaching, lecturers and individual or personal study through which they were prepared for CPD. Engaging with lecturers during lectures, peers in the peer teaching and STP were formally structured in the teacher educational programmes and hence considered as compulsory ways of preparing PSTs for CPD. Engaging in STP and peer teaching and learning from the lecturers are context-dictated, formal and structured compulsory ways, can work toward preparing PSTs for CPD. However, they cannot be considered as 'stand-alone' ways of preparing PSTs for CPD. Neither can they stand as 'one-size fits all' approach for preparing PSTs for CPD a point that Day (1999) and other scholars have referred to. Therefore, there is also need for mathematics teacher preparation programmes to consider availing opportunities for PSTs to engage in other formal forms of CPD as well as to engage in recognised informal and self-directed CPD activities. This would not only contribute to the preparation of PSTs to engage in a variety of CPD activities, but also preparing them to exercise their autonomy and make their own professional judgement to engage in wide range of CPD activities that would meet their learning and CPD needs.

The ways by which the PSTs were prepared for CPD were within their university and schools (for their STP) cultural practices. Within the context of the sociocultural framework there is need to take into account cultural, institutional, individual and social factors as well as their interdependence as they relate to learning and development (Gosselin, Northcote, Wuensche, Stoddard, 2017). Understanding mathematics PSTs' views as they relate to their CPD preparation contexts and ways can facilitate understanding contextual factors that can facilitate or constrain their preparedness for CPD and act accordingly. This could lead to exploring strategic and context relevant ways of cultivating, in the PSTs, a mind-set for knowledge and key learning competencies and skills acquisition from a variety of avenues.

5.4 PSTs perceptions regarding the way(s) by which they were prepared for CPD

Majority indicated that they were not prepared for CPD while few indicated they were. Some mentioned a single way through which they considered to have been prepared for CPD while

for a few others it was a combination of different ways. No one form of CPD activity can be said to be sufficient on its own throughout or at any stage of one's (teaching) life. Timperley et al. (2008) explain that a single CPD-supporting form or type cannot in itself be considered more effective than the other or be taken as sufficient for improving one's teaching practices or to meet teachers' varying learning and development needs. Subsection 2.2.3 and 2.2.4 have presented and illustrated different activities that can support a teachers' professional growth. El-Deghaidy, Mansour and Alshamrani (2015) also refer to different types of CPD and CPD content. The argument remains that no one type of activity is complete without limitations. Several can complement each other. An argument supported by Loucks-Horsley et al., 2010, pp. 152-153) when they state that 'PD is "not one size fits all" but rather should be a combination of strategies'. PSTs may need to beware of this if they are to be prepared to consider and engage in several CPD activities in their contexts to meet their different learning and development needs.

As mentioned earlier there were cases were the PSTs stated the current shortcomings of what was being done/had been done to prepare them for CPD and also in others suggesting what they thought could enhance their preparation for CPD. These are discussed here and below.

To start with, while there was an acknowledgement of the crucial role of peer teaching in preparing them for their professional teaching roles, there was also some concerns which needed to be addressed for maximising on the benefits thereof. One such concern is raised by the PSTs is in relation to the lack of skills for managing increased levels of fear and anxiety before, during and after the peer teaching sessions. Such anxiety and fear can negatively impact on their development of teaching skill. Studies such as by Bilen (2015) and Basturk &Tastepe (2015) have shown that among factors that have negatively impacted on pre-service teachers' development of core teaching skills are anxiety and fear of making mistakes. Knowledge of and development of anxiety management skills could help. However, while peer teaching can be an anxiety-provoking activity, it can also work toward helping students explore ways of managing stress and lowering anxiety that could work for themselves. For instance, knowing the cause(s) of the anxiety could be one way of helping themselves to reduce it when given another opportunity to teach. Such are among suggestions offered by scholars such as Maulimora (2019). The idea that by teaching we learn (Duran, 2017) holds too here.

In addition, PSTs' views also indicated that being observed teaching by the lecturer and or HOD and or serving teacher was being viewed from the angle of being judged or as a way of

finding faults. Critiquing is among the essential teaching practices (Beyer & Davis 2009) and a critical feature of LS (Cheng & Yee, 2012; Banda, 2011), which is the most common SBCPD in Zambian Schools. PST may need to be supported not only to develop the capacity to creatively critique a lesson, but also to receive and handle a critique.

Further, PSTs' concerns related to the inadequate (and lack of, in some instances) use of technology in teaching in general and in peer teaching in particular in their teacher training institution. Mukuka and Alex (2023, p.9) contend that *'When it comes to the improvement of microteaching's standing in the development of teaching capabilities among pre-service mathematics teachers, technology has shown more potential'*. It can help in the PSTs maximising on the benefits of peer teaching. Technology can also facilitate the making of CPD preparations more practical and meaningful through asking the PSTs to design a CPD plan for themselves, among other things. This would not only lay the foundation for them to be more intentional and proactive about their professional development but would also prepare them to keep a record of their CPD engagements-something similar to what TCZ would expect of them in future. The benefits of using technologies and possessing technological skills extend to one's personal (teaching) life in the present and future too. There was no reflection or indication of use of technology in peer teaching in the PSTs course/programme outlines that were available in this context and the lecturers did not comment on the matter at hand. While no comment was made by the lecturers' on this, it can be stated that their consideration of the use of technology to maximise on the benefits on PSTs' preparation for teaching, learning and development would need to be called upon. The use of technology has been discussed further below.

PSTs' (re)emphasised the role model role of their lecturers in as far as CPD matters were related. One such suggestions related to lecturers' role in modelling the place and use of technology in the teaching and learning in general and in CPD in particular. While contexts may differ, research generally shows 'technology enhanced learning is often expected by students' (Compton & Almpanis, 2018, unpaignated). PSTs' responses were to the effect that: lecturers could demonstrate using technologies for teaching and also how they were using technologies for their own learning and development. **PSTI7** for instance stated that: *'...I have not seen my maths lecturer's works like research or publications or recoding of teaching online ...they are not visible online like other lecturer...'*. While this is a reflection of their reality, the Lecturers being referred to in this case could have 'their reality' and logical and

reasoned arguments for their (in) actions in relation to technology in this case. Some are as shared by Compton and Almpanis (2018) for instance and which may be beyond the scope of this study. However, it remains to be stated that PSTs responses can lead to making Gallimore and Tharp's (1992) definition of modelling by teacher educators as cited by Lunenberg et al (2007, p.588) that: *'...as the practice of intentionally displaying certain teaching behaviour with the aim of promoting student teachers' professional learning'* a key statement here. It suggests that their (lecturers) being intentional about their role modelling role can result in displaying their commitment to and future uptake of CPD. Modelling by teacher educators can be used 'as a means of changing the views and practices of future teachers (Lunenberg et al., 2007, p.586) for the good. The teacher educator role model role has potential to enhance teacher education with respect to the student teachers' learning processes and achieving the learning outcomes for the teacher education programmes such as reflected in one of the course outlines for the PSTs in this study and as hinted by Lecturer LI1.

Summary of discussion on PSTs perceptions regarding the way(s) by which they were prepared for CPD.

As a way of merging the discussion points related to research question 3 the following is stated: Constructivism places learners at the centre of their learning and emphasises active engagement in knowledge generation. The PSTs, in this study were considered to have had a pivotal role to play in their own preparation for professional development which was evidenced in their being positioned to learn about CPD, reflectively identifying their learning needs, actively engaging in activities, in any teaching/learning context, that supported CPD. They generally did not share a confident sense of preparedness for CPD, but were able to state what they perceived as concerns and current shortcomings associated with the ways of being prepared for CPD and also suggesting how they could be addressed. Their reflections, to an extent demonstrated their ability to identify learning needs or gaps and how they could be met- an ability that needs to be extended to identifying their CPD needs. This in ways suggested that PSTs needed to be initiated into and supported in identifying their learning needs as well as initiatives that could be available for them to engage in, to meet the identified and acknowledged needs. At another level their reflections and reflection points could be considered as a reflection of their learning needs which Mathematics teacher educators and relevant stakeholders (in MOE, Schools) should consider as ways of informing the focus or content of initiatives for preparation of PSTs for CPD. This further pointed to the need to review the PSTs curriculum content (as it related to CPD) and practical implementation

strategies as a way to facilitate acquiring and assessing appropriate holistic CPD-related information and further developing PSTs' creativity, PSTs' reflective and reasoning abilities as well as sound mindedness in making judgements regarding their CPD needs.

Specifically, there was an indication that there was need to address the concerns raised if PSTs preparation for CPD was to be advanced. The strategies for addressing the concerns raised included extending the view that knowledge, skills and competencies for CPD not only be presented in course content (to be) taught, but also in exposing PSTs to more varied opportunities for reflectively practicing these skills and developing a positive mind-set for CPD. With reference to the constructivism and sociocultural framework, lecturers and (mentor) teachers in the schools were the PSTs did their STP, should be there to facilitate PSTs' learning about and engaging in CPD supporting activities. Addressing the concerns raised by the PST regarding their preparedness for CPD therefore requires strategies for strengthening this facilitative role. This includes mind-set change. It includes that lecturers' role in preparing PSTs for CPD and hence lifelong learning not only be viewed as beginning or ending with teaching CPD-related content but extended to strategically assessing CPD-related knowledge, values and skills in practice and in context. This means to cover developing knowledge and skills for determining context relevant effective ways of assessing PSTs' engagement and commitment of CPD and assessing the success of teacher education programmes in adequately preparing PSTs for CPDs. Furthermore, lecturers' role should extend to role modelling engagement in and commitment to CPD. This suggests that Mathematics teacher educators should be intentional about role modelling CPD to student teachers including through the use of technology.

The above, together with reference to other literature, contributed to the development and proposition of a CPD preparation Framework even though not one of initially intended deliverables of the study. The framework comprises two Interrelated Plans named: the PSTs' CPD preparation plan and the PSTs CPD Plan. The former to be mainly used by the teacher educators in planning for, guiding and preparing the PSTs for CPD and the later to be used by the PSTs themselves. The plans present some kind of structure to facilitate intention-illuminated action toward preparing PSTs for CPD. Details of the framework with the two interrelated plans have been provided under Appendix E.

5.5 Summary

This chapter has discussed the findings of the study in relation to the research questions. The PSTs in this study had indicated divergent conceptualisation of CPD which was largely limited and limiting. This has potential to hamper their (future) engagement and commitment to CPD if not addressed. With regard to the perceptions of how the PST were prepared for CPD, the study showed that STP was identified as the dominant way through which PSTs were prepared. The central theme of the discussion was around exposing PSTs to a wide variety of CPD supporting initiatives which are formal and structured, and recognised informal and self-directed CPD activities. From the findings, it was clear that the PSTs did not share a confident sense of preparedness for CPD, but did state what they perceived as concerns and current shortcomings associated with the ways of being prepared for CPD. There was need to address the concerns raised as it would be a way toward achieving the goal of preparing PSTs for CPD and lifelong learning. A framework comprises two Interrelated Plans named: the PSTs' CPD preparation plan and the PSTs CPD Plan was proposed. Appendix E provides details on the suggested framework with the two interrelated plans.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Overview

The previous chapter discussed findings of the study. This chapter presents the conclusions of the study contributions to knowledge in the field and recommendations of the study.

6.2 Summary of key findings and conclusions

The key research findings and conclusions discussed have been presented under the subheadings of: conceptions of CPD, ways of preparing for CPD and perception of ways of being prepared for CPD as aligned with the research questions of the study.

6.2.1 Conceptions of CPD

The study showed that the PSTs had varied conceptualisation of CPD and that their perception, conceptualisation and description of CPD presented was limited and limiting at the same time. It is concluded that if this is not addressed then it is likely to negatively impact on their (future) engagement and commitment to CPD.

The study also established that self-directedness and intrinsic motivation for CPD and learning was an aspect of CPD that also seemed to be detached from the commonly held perceptions of CPD by the PSTs in the study. Lack of self-directedness in as far as CPD and lifelong learning were concerned could impair their ability to exercise autonomy and make their own professional judgement to engage in wide range of CPD activities that would meet their learning and CPD needs in the short and long run

6.2.2 Ways of being prepared for CPD

The study has established that STP was the dominant way through which PSTs perceived they were prepared for CPD. It is concluded that there is need to expose PSTs to more than they are currently exposed to when on their STP with respect to varied CPD activities and CPD focus. This would be to allow for acquisition of: holistic foundational knowledge of continuing learning and of one as a learner, wide range of skills and learning strategies as well as assessment and ascertaining of the PSTs engagement and commitment to CPD during STP. It would also allow for PSTs to appreciate that what they are gaining is initial preparation for learning which should be built upon.

The study showed that in addition to STP, there were other ways through which PSTs were prepared for CPD. These included peer teaching, lecturers and individual or personal study. Engaging with lecturers during lectures, peer teaching and STP were considered as formally structured in the teacher educational programmes and considered as compulsory ways of preparing PSTs for CPD at the almost neglect of self-directed way of preparing for CPD.

6.2.3 Perception of ways of being prepared for CPD

The PSTs' generally did not share a confident sense of preparedness for CPD. The study broadly showed that despite this the PSTs were still able to state what they perceived as concerns and current shortcomings associated with the ways of being prepared for CPD and also suggested how they could be addressed.

Specifically, the study established that while knowledge and skills for CPD can be presented in course content (to be) taught, the PSTs needed more opportunities for reflectively practicing these skills and developing a positive mind set for CPD in their learning environment. Additionally, the study revealed that lecturers' role in preparing PSTs for CPD and hence lifelong learning did not begin or end with teaching CPD-related content but, extended to strategically assessing such knowledge, values and skills in practice and in context. The role also extended to lecturers' role modelling engagement in and commitment to CPD. Therefore, suggesting that Mathematics teacher educators be intentional about role modelling CPD to student teachers including through the use of technology. Two interrelated plans, that is, PSTs CPD preparation Plan and PSTs CPD Plan A depicting a contextualised growth strategy were proposed to facilitate and enhance the ultimate quest to adequately prepare PSTs for CPD and lifelong learning.

6.3 Contribution to Knowledge

There are several studies focussing on CPD for in-service teachers and generally a dearth of literature for CPD for pre-service teachers and preparation of pre-service teachers for CPD in particular especially with respect to the Zambian context. This study contributes to narrowing this knowledge gap as it discusses CPD with respect to pre-service teachers and particularly the preparation and preparedness of secondary school Mathematics pre-service student teachers for CPD. The other form of contribution is the development and proposition of a CPD preparation Framework which comprises two Interrelated Plans named: the PSTs' CPD preparation plan and the PSTs CPD Plan. The former to be mainly used by the teacher

educators in planning for, guiding and preparing the PSTs for CPD and the later to be used by the PSTs themselves. The plans present some kind of structure to facilitate intention-illuminated action toward preparing PSTs for CPD. Thus there are also practical contributions. implications. Further knowledge contributions are with respect to: raising awareness and stressing the importance of assessing PSTs engagement and commitments to CPD during University time and during the time of their STP and; emphasising the lecturers' role of role modelling engagement in and commitment to CPD including use of technology in the quest.

6.4 Recommendations

The following recommendations arose from the study.

i. Mathematics teacher educators at the university to consider reviewing the PSTs course content (as it relates to CPD) as a way to facilitate PSTs acquiring correct comprehensive and holistic CPD-related information as well as developing a positive mindset for it.
ii. Mathematics teacher educators at the university at the university to consider reviewing CPD implementation and assessment strategies to increase the reflective practices as a way to facilitate developing a positive mind-set and relevant competences for CPD and lifelong learning.
iii. Mathematics teacher educators to take kin interest and be intentional about role modelling engagement in and commitment to CPD including through sharing of real life CPD experiences and use of technology in CPD-related quests.
iv. The Ministry of Education to finalise the CPD framework for teachers in Zambia, as this could help Mathematics teacher educators and the PSTs themselves use it as reference or guide on matters of CPD in their context.
v. MoE should ensure that there is efficient and comprehensive CPD in secondary schools so that serving teachers and student teachers on STP, for instance, are further exposed to continuous learning, knowledge acquisition and sharing as well as skills development for their improved mathematics CPD teaching/learning life experiences.

6.5 Possible future research areas

In view of the findings of this study which looked at the preparedness of mathematics PSTs for CPD, it is necessary to propose some areas for further research.

i. An investigation into Mathematics PSTs competencies for lifelong learning and CPD.

ii. Perceptions of former mathematics students who are already serving mathematics teachers on their preparation for CPD while at the university and link to their present CPD experiences in the field.

iii. An investigation into how mathematics PSTs at another public university in the country is being done. This could give the lecturers on opportunity to expand their knowledge base on the preparation of PSTs for CPD and lifelong learning.

iv. Further research into the applicability of the proposed framework for providing structure that could be used to achieve the goal of preparing pre-service for CPD.

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APPENDICES

Appendix A: Students' Questionnaire

STUDENTS' QUESTIONNAIRE

Dear Respondent,

The purpose of this questionnaire is to gather information concerning Mathematics student teachers' continuing learning (even after graduation) or continuing professional development. The information gathered will be for academic purposes and it will be treated with anonymity and confidentiality. You do not need to write your name on the questionnaire.

SECTION A

Please respond to all statements.

1. Gender:_____2. Subjects of specialization: _____

SECTION B

There are no right or wrong answers for the items that follow. Please give your honest opinion. Write your answer in the space provided.

1.What comes to mind when you hear about CPD?

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.....
.....

2. Is it important for student teachers to have knowledge about CPD. Please give reason(s) for your answer.

.....
.....
.....

3.What is it that you think student teachers should know about continuing learning (CPD) even after graduating?

.....
.....
.....

4.How has CPD-related information been taught to you as a student teacher?

.....
.....
.....

5.What specific CPD- related content has been taught to you through the ways identified in '4' above?

……
……
……

6. What do you think should be done to adequately prepare student teachers for CPD? Give reason(s) for your answer.

6. What do you think should be done to adequately prepare student teachers for CPD? Give reason(s) for your answer.

……..….....
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End of questionnaire.

Thank you for your participation

Appendix B: Interview Guide for Students

INTERVIEW GUIDE FOR STUDENTS

The purpose of this questionnaire is to gather information concerning Mathematics student teachers' continuing learning (even after graduation) or continuing professional development. The information gathered will be for academic purposes and it will be treated with anonymity and confidentiality.

Key questions and prompts

1.What comes to mind when you hear the words 'Continuing Professional Development (CPD)'?
Prompts could be in line with answers given on the questionnaire and/or could be in line with views on: What it is e.g in line with literature read/what it entails

2.Is it important for student teachers to have knowledge of Continuing Professional Development(CPD)? Please give reason(s) for your answer.
Prompts could be in line with answers given on the questionnaire and/or could be in line with views on: Reasons/value/need for (CPD)/lifelong learning

3.What is it that you think student teachers should know about Continuing Professional Development?
Prompts could be in line with answers given on the questionnaire and/or could be in line with views on: What it is/involves/accountability for it

4.How has Continuing Professional Development -related information been taught to you as a student teacher?
Prompts in line with answers given on the questionnaire and could be in line with views on: Lectures/projects/Activities/Tasks

5.What specific Continuing Professional Development related content has been taught to you through the ways identified in '4' above?
Prompts could be in line with answers given on the questionnaire and/or could be in line with views on: What it is/involves/need/value/outcomes

6. What do you think should be done to adequately prepare student teachers for Continuing Professional Development? Give reason(s) for your answer.
Prompts could be in line with answers given on the questionnaire and/or could be in line with views on: Ways/methods/strategies of teaching

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End of interview.

Thank you for your participation.

Appendix C: Interview Guide for Lecturers

INTERVIEW GUIDE FOR LECTURER

The purpose of this interview is to gather more information about the preparation and **preparedness** of secondary school Mathematics pre-service student teachers for continuing professional development. The information gathered will be for academic purposes and will be treated with anonymity and confidentiality.

Key questions and prompts

1. Is it important for student teachers to have knowledge of Continuing Professional Development/lifelong learning? Please give reason(s) for your answer.
   Prompts could be in line with views on:
   - Need/value for CPD/lifelong learning
2. What is it that you think student teachers should know about Continuing Professional Development/lifelong learning?
   Prompts could be in line with views on:
   - Content/coverage/forms of
3. How has Continuing Professional Development/lifelong learning -related information been taught to the Mathematics Student Teachers?
   Prompts could be in line with views on:
   - Ways/Methods/approaches/strategies of teaching
4. What do you think should be done to adequately prepare Mathematics student teachers for Continuing Professional Development/lifelong learning? Give reason(s) for your answer.
   Prompts could be in line with views on:
   - Meaning of adequate preparation
   - Content/Coverage
   - Other ways/Methods/approaches/strategies of teaching/ projects/programmes

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End of interview.

Thank you for your participation.

INTERVIEW GUIDE TURNED INTO QUESTIONNAIRE FOR LECTURER(S) - prepared but not used

The purpose of this questionnaire is to gather more information about the preparation and preparedness of secondary school Mathematics pre-service student teachers for continuing professional development. The information gathered will be for academic purposes and will be treated with anonymity and confidentiality.

Q**uestions**

1. Is it important for student teachers to have knowledge of Continuing Professional Development/ lifelong learning? Please give reason(s) for your answer.
   ……..….....
   .....
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   .....
2. What is it that you think student teachers should know about Continuing Professional Development /lifelong learning?
   ……..….....
   .....
   .....
   .....
3. How has
   Continuing Professional Development/lifelong learning -related information been taught to the Mathematics Student Teachers?
   ……..….....
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   .....
4. What do you think should be done to adequately prepare Mathematics student teachers for Continuing Professional Development /lifelong learning? Give reason(s) for your answer.
   ……..….....
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End of interview.

Thank you for your participation.

Appendix D: Document Review Checklist

DOCUMENT REVIEW CHECKLIST

SNº	**Document name**	**Document (content) Description**	**Availability (Yes or No)**	**Document content relevant to the research study (Yes or No)**
1.	Programme/course outlines for students taking Mathematics	Mathematics (Teaching) course content.	Yes	Yes
2.	Student notebook/folder/handout(s) for Mathematics course(s)	Notes/write up reflecting CPD-related content	Yes	Yes
3.	2013 Zambia Education Curriculum Framework	CPD related Information and guidance given the same (CPD)	Yes	Yes
4.	CPD Framework for teachers in Zambia	CPD related Information and guidance given the same (CPD)	Yes (in Draft form)	Yes
5.	Strategic Plan for Teacher Education: 2000-2015	CPD related Information and guidance given on CPD	No	-
6.	Zambia Education Enhancement Programme (ZEEP) School Experience Guidelines and Assessment Rubric.	CPD related Information and guidance given on the same (CPD)	Yes	Yes
7.	University School Experience instrument Guidelines/Policy	CPD related Information and guidance given on the same (CPD)	Yes	Yes
8	University School Experience Guidelines/Policy	CPD related Information and guidance given on the same (CPD)	Yes	Yes
9.	Course outline for the Basic Teacher Education	CPD related Information and guidance given on the same (CPD)	No	Yes

Document review checklist further details

SNo	Document name	Document (content) Description	Availability (Yes or No)	Document content relevant to the research study (Yes or No)	Specific document content relevant to the research study and frequency
1.	Course outlines for third year students taking Mathematicss	Mathematics (Methodology-related) course content.	Yes	Yes	-Teacher Knowledge (appearing 2 times) Page 3 -Increasing teacher knowledge Page 3
2	Course outlines for fourth students taking Mathematics	Mathematics (Methodology-related) course content.	Yes	Yes	-CPD (1) Page 3
3.	Student notebook/folder/handout(s) for Mathematics course(s)	Notes/write up reflecting CPD-related content	Yes	Yes	-CPD meaning -4 CPD supporting activities -5 Challenges associated with CPD
4.	2013 Zambia Education Curriculum Framework	CPD related Information and guidance given on the same (CPD)	Yes	Yes	-CPD (appearing 4 times) Pages VI, 48 and 60 -CPD Focus for teachers and teacher educators Pages 60 -Trainee (Once) -School experience (7 times) Pages II, VIII, 5, 49 -life-long learning (4 times) Pages X, 17
5.	Test Paper for third year Mathematics (Methodology-related) course	CPD related Information and guidance given the osame (CPD)	Yes	Yes	Teacher knowledge (1)
6.	Test Paper for fourth year Mathematics (Methodology-related) course	CPD related Information and guidance given on the same (CPD)	Yes	Yes	-CPD supporting activities (1) -challenges associated CPD (1)
7.	University School Experience instrument	CPD related Information and guidance given on the same (CPD)	Yes	Yes	No
8	University School Experience Guidelines/Policy	CPD related Information and guidance given on the same (CPD)	Yes	Yes	STP guidelines, lifelong learning (1) on page 15 professional development (1) page 3
9	University's Peer teaching evaluation instrument	CPD related Information and guidance given on the same (CPD)	Yes	No	No

Appendix E: Proposed CPD preparation Framework

The framework comprises two Interrelated Plans named: the PSTs' CPD preparation plan and the PSTs CPD Plan. The former to be mainly used by the teacher educators in planning for, guiding and preparing the PSTs for CPD and the later to be used by the PSTs themselves. The plans present some kind of structure to facilitate intention-illuminated action toward preparing PSTs for CPD.

Rationale for the proposed CPD preparation plans for PSTs

The proposed PSTs CPD preparation Plan and PSTs' CPD Plan are a synthesis of some of the findings of this broader study on which the paper is based and ideas extended in the works of various authors including Ouane (2002); Cropley & Dave (2014); European Commission (2019); Ooi (2020); Mann & Webb (2022) and; Kilag, Malbas, Miñoza, Ledesma, Vestal & Sasan (2023). The research questions for this research study were: a. What are mathematics pre-service student teachers' conceptions of CPD?; b. How are mathematics pre-service student teachers' prepared for CPD? and; c. What are the perceptions of mathematics pre-service student teachers' regarding the way(s) by which they were prepared for CPD? Based on the collected and analysed data for the broader research, the PST research participants indicated divergent conceptualisation of CPD which were largely limited and limiting. An example being CPD '… *is the meeting which is conducted by the department to present work'*. The PSTs' views of CPD could have been based on their context and experiences such as experience of School Teaching Practise (STP). However, if focus is on CPD being meetings or attendance of meetings, then it shifts attention from what is considered as holistic picture of PD as presented by Day (1999). The central theme of the interpretation and discussion of data collected was around exposing PSTs to a holistic view of CPD and to a wide variety of CPD supporting initiatives which may be formal and structured, and recognised informal and self-directed CPD activities. The PSTs generally did not share a confident sense of CPD and of preparedness for it.

Some also shared what they perceived as concerns and shortcomings associated with the non-practicalness of their teacher education and preparation for continuing learning. *'… it is bookish and remains unreal…'* one PST stated during an interview and another stated in the questionnaire that '*…emphasising the importance of CPD to us, making it practical, real… and helping us see the link between what we are being taught and what is happening practically on the ground in relation to CPD …can help us a lot…*'. Thereby suggesting that there was a need

to address the concerns raised. While the importance of empowering pre-service to actively engage in their CPD is acknowledged in literature including Mann and Webb (2022) there appears to be a gap regarding frameworks or structure that could be used to achieve this goal in teacher education. The proposed PSTs CPD plan may not only contribute to this goal and show how practical and real CPD-related matters are, but also guide and contribute to empowering PSTs to (further) reflect on their learning needs and possible wide range of CPD-supporting activities that could be accessible in specific contexts and could meet their identified learning needs. Context matters. It is in the context of different pre-service student life situations and learning needs that key competencies could be contextualised (Ouane, 2002). The use of the proposed plans could be a start for the Mathematics teacher educators in their preparing PSTs for CPD and boost their ability to take responsibility of their own learning and development. The plans are meant to be flexible enough for both the lecturers themselves and the PSTs. They allow PSTs flexibility, during university learning times or during school teaching practice (STP) or Practicum times to reflect, profile and clarify their learning needs and engage in PD-supporting activities in order to meet the identified needs and for assessors or monitors to keep track of PSTs' progress in the process.

Structure of the Proposed CPD preparation Plans for PSTs

A. The proposed PSTs' CPD preparation Plan

The proposed PSTs' CPD preparation Plan and may have to be used by the lecturers as a guide as they plan and implement CPD preparation for the Mathematics PSTs. Reference is made to Table 1 below with 6 columns. Column one indicates CPD -supporting activities categories. Three categories have been presented and examples of CPD -supporting activities under each shared. A mixture of activities is encouraged in recognition of the different ways of learning available and of the point that PSTs are highly likely to have different learning needs that can be met in different ways. The list of examples provided is not exhaustive, but simply there to give ideas of what could be done in different contexts and keep the PSTs aware. Column 2 indicates the timeline within which CPD-supporting activity could be undertaken. The third column shows the expected outcomes. These could have to be in line with growth mind-set for CPD; lifelong learning and CPD competences; knowledge increase as may be facilitated by each CPD supporting activity (to be) undertaken. The fourth column is meant for the evaluation method to be employed to help ascertain the achievement of the expected outcomes. The fifth and last column are also self-explanatory and as briefly under Table 1.

Table 1: Sample proposed PSTs CPD preparation Plan

CPD - supporting activities categories	**Time line**	**Expected Outcome**	**Evidence and evaluation strategy/method**	**Responsible personnel**	**Comment(s)**
Each category and as many necessary examples given. <u>Compulsory</u> Examples include: -Peer teaching -Lesson study <u>Self-Directed</u> Examples -Reading a Journal article -Webinar attendance <u>Others</u> Examples -voluntary work (e.g tutoring)	An expected completion date to be defined for each CPD supporting activity (to be) undertaken	Expected outcomes: -to be defined for each CPD supporting activity (to be) undertaken.	The evidence for and evaluative measure to be defined for each one of the CPD supporting activity	Responsible individual(s) to be identified for (facilitating) each one of the CPD supporting activity	While this may be optional comments can be made with respect to (no) progress made/not made

The whole process of preparing PSTs for CPD and planning for it in this manner starting with considering the information to be presented in a plan of this nature may not be readily accepted by lecturers. This could be because it could be regarded as an additional responsibility by lecturers who are generally said to have heavy workload and time constrained. However, it may need to be considered necessary as it could be one way of being more intentional about and providing evidence of being aware of relevance of laying a solid foundation for CPD and acting in line with the goal of preparing PSTs for their CPD.

B. <u>The proposed PSTs CPD Plan</u>

The lecturers of Mathematics may have to lead the PSTs to developing what is here considered as a PSTs' CPD Plan. Table 2 below shows the structure of the proposed generic PST CPD Plan. This plan is not meant to be complex or extensive, but to simply show the PSTs' reflection regarding their own learning and what could potentially be done to meet the learning needs and when.

Table 2: Proposed PSTs CPD Plan.

Name of Student:	**Student Identification Number:**			**Signature:**	
Area/Skill I need to develop	Action to be taken	When action is to be taken	Expected learning outcome	Actual learning outcome	Next Step(s) to be taken
Lecturer/Supervisor/Mentor's name:				Signature:	

The accompanying information for each row/column is generally self-explanatory, but is briefly explained below: The first row is meant to capture each PST's identification details including the name and the student identification (SI) number. The second row shows 6 columns within it. The first column in row 2 is designed for the PSTs to identify their area of need which could be professional and or personal area of need with respect to (technical or non- technical mathematics) knowledge or skills or competences relevant to their (future) teaching career. The second column is meant to be completed with a mixture of CPD-supporting activities as explained above with respect to Table 1 and as guided by the lecturers. The third column is meant for indicating when action is planned to be taken. This is about the date/time period when the CPD-supporting activity is to be undertaken. The PST would be expected to indicate the date/period they attended a CPD-supporting activity to meet the

identified area of need (as would be shown in the first Column of Row 2). The fourth column is meant for the expected learning outcome and the fifth for recording the actual learning outcomes from the CPD activities engaged in. Recording the (expected) learning outcome(s) of the CPD-supporting activity undertaken/attended is meant to encourage the PSTs to reflect upon and evaluate what they would have learnt. It is also meant to facilitate identification of future learning needs and next possible actions to be taken to be taken which would then have to be recorded in the last column. The custodian of the blank copies of the plans is the lecturer and s/he is the one to give the students their copy of *Proposed PSTs CPD Plan*. A copy of the completed plan is to be shared with the PSTs' assigned lecturer(s) in the university and filed in the PST's teacher's teaching file when the PST is on STP. Other copies could also be shared with supervisors such as the Mathematics Head of Department (HOD) when on STP. Thus the lecturers would also have a plan to use as reference or guide or assessment tool for matters of CPD in their context. Additionally, the PSTs' teacher-mentors in schools, supervisors including HOD, can use it to monitor and assess the PSTs engagement and commitment to CPD while on STP.

As with the lecturers, the whole process of considering the information to be presented as a way of completing the PSTs' CPD Plan form of this nature could be regarded as an additional responsibility by the PSTs who already hint on the heavy work/course loads. However, it may need to be considered necessary as it would be one way of providing evidence of awareness of, engagement and commitment to CPD. This would be one way of practically preparing the PSTs to adapt relatively well when they commence teaching, after successfully completing their studies, as the teaching profession involves meeting CPD requirements and expectations. While CPD supporting activities may arise opportunistically, at the core of one's development and growth is being intentional and (pre)planning for it- a lesson the PSTs may have to learn too.

Conclusion

Teacher Education is intended to not only prepare pre-service teachers (PSTs) but to also continue learning themselves. This section has presented an overview of a framework comprising two interrelated CPD plans, named: PSTs CPD preparation Plan and PSTs CPD Plan, that has been developed and proposed to contribute to preparing PSTs for CPD. They are designed to contribute to Mathematics teacher educators' efforts at preparing PSTs for CPD and at the same time enhance PSTs engagement in their own preparation for CPD while also raising awareness among them of the importance of CPD and lifelong learning. The plans

demonstrate intention-illuminated action that could be taken toward preparing PSTs for CPD and potential practical benefits to their usage.

The broader research study from which the framework reported has been drawn was qualitative in nature. This implies that the findings of the study including the framework may not be generalizable in the traditional sense. However, it provides insight into a framework or structure that could be used to achieve the goal of empowering and preparing pre-service to actively engage in their CPD. The proposed and recommended plans may have their own limitations and downsides, but their adoption or adaption still worth considering in enhancing preparation of Mathematics (and possibly of other teaching subjects or subject specialism) PSTs for CPD. Further research may help refine it as would testing it. Additional exploration may be needed to further understand how Mathematics and or possibly other disciplines and across diverse cultural contexts might adopt/adapt and benefit from (using) the framework for preparing PSTs for continuing learning.

Appendix F: Sample of Data analysis process

Relating to Research Question 1

An analysis of the words making the responses in the questionnaire and during interviews that the PSTs' used that contributed to the generation of themes are presented in the table below.

Words reflecting PSTs conceptualisation of CPD

Words contributing to theme generating and number of times mentioned (frequency)		**Theme generated**
Questionnaire	**Interviews**	
Lifelong learning (29) Related words learning for life (11); Continuous learning (10); Continuing learning (8)	**Lifelong learning (35)** Related words learning for life (13); Continuous learning (10); Continuing learning (8); Learning (4)	CPD as Lifelong learning
Meetings (20) Related words Meeting others (11); Attending meetings (8); Meeting attendance (2)	**Meetings (27)** Related words Meetings with other teachers (17); attending meetings (10)	CPD as Meetings
Upgrading qualifications (20) Related words Upgrading (9); Qualifications improved (8); further studies (3)	**Upgrading qualifications (23)** Related words Further studies (10); Upgrading (7); Qualifications improved (6);	CPD as upgrading qualifications
Mandate for teachers (18) A must (15); Mandated (3)	**Mandate for teachers (23)** A must (16); Mandatory (5); Mandated (2)	CPD as mandate programme for teachers

The above indicate the different themes showing the conceptualisation/understanding of CPD that emerged: CPD as lifelong learning, CPD as meetings, CPD as upgrading one's qualifications and CPD as a programme mandate for teachers.

Relating to Research Question 2

An analysis of the words making their responses in the questionnaire and during interviews that they used that contributed to the generation of themes are presented in the table below.

Words showing PSTs perceptions of ways of being prepared for CPD

Words contributing to theme generating and times mentioned(frequency)		**Theme generated**
Questionnaire	**Interviews**	
School Teaching Practice (STP) (38) Related words School Experience (15); School Teaching Practice-STP (9); School Lesson Study (8); School Departmental meeting (6)	**School Teaching Practice (STP) (51)** Related words School Teaching Practice-STP (17); School Lesson Study (15): School Experience (12); School Departmental meeting (7)	**School Teaching Practice (STP)**
Peer teaching (16)	**Peer teaching (30)**	**Peer teaching**
Lecturers (18)	**Lecturers (21)**	**Lecturers**
Personal study (7) Related words Individual study (3); personal reading (2); personal study (2)	**Personal study (10)** Related words Individual study (4); personal reading(3); personal study(3)	**Personal study**

Therefore, showing that the themes that emerged were: School Teaching Practice (STP), Peer teaching, and lectures and personal study as ways through which they were (being) prepared for CPD. Findings in each case are presented below.

Appendix G: Peer teaching Observation instrument

DEPARTMENT OF MATHEMATICS AND SCIENCE EDUCATION

PEER TEACHING MARK ALLOCATION GUIDELINES

Student's Name:.....

Date:.....**Duration:**.....**Time: From**.....**to**.....

Topic:.....

Subtopic/Lesson:.....

SNo	Category	Marks (out of)	Marks awarded
1	Lesson plan/lesson preparation	7	
2	Introduction	5	
3	Lesson Development	10	
4	Knowledge of the subject	10	
5	Board work/ Board management	5	
6	Classroom management and control	5	
7	Class participation	5	
8	Questioning techniques	5	
9	Timing/Time management	5	
10	Teaching aid(s)-other than chalk/whiteboard (consider resourcefulness, appropriateness etc)	5	
11	Individual learner attention	3	
12	'Teacher'-'pupil' relationship (general impression)	3	
13	Use of mathematical language	5	
14	Correct use of language of instruction	5	
15	Achievement of stated objectives	5	
16	Class exercise/Homework	3	
17	Conclusion of the lesson	5	
18	Voice projection and clarity	3	
19	General behavior (mannerism)	3	
20	How presentable the teacher is (dress, posture etc)	3	
	Total Marks	100	

General comment about the lesson:.....

.....

Observer's name:.....**Signature:**.....

Student's Signature:.....

Appendix H: STP Observation Schedule

SCHOOL EXPERIENCE
LESSON EVALUATION FORM

To be completed in duplicate and distributed as follows:
Original copy - Student Teacher
Duplicate copy – SE Coordinator

GENERAL PARTICULARS

STUDENT'S NAME: ..... [redacted] .....

SCHOOL: ..... GRADE: .....

DATE: .....TIME: ..... DURATION: .....

SUBJECT..... LESSON/TOPIC: .....

GUIDELINES TO THE OBSERVER

Award a maximum of 5 points on each of the aspects. At the end of the observation, make a total of the score out of 100.

	For official use
1. Maintenance of teaching file	
2. Lesson Objective/s	
3. Introduction of the lesson	
4 Development of the lesson	
5 Knowledge of the subject	
6. Teaching Methods	
7. Board management	
8. Teaching/Learning aids (resourcefulness, appropriateness etc)	
9. Questioning Technique	
10. Class participation	

1

11. Teacher – pupil relationship

12. Application/Evaluation activity/exercise

13. Command of language

14. Relevance of preparation during the lesson (does teacher follow what was prepared?)

15. Voice clarity and projection

16. Dress, posture and suitability of gestures etc.

17. Class management

18. Time allocation/management

19. Lesson conclusion

20. General impression of the lesson as a whole

OTHER COMMENTS

SCORE

NAME OF STUDENT:..... SIGNATURE:.....

NAME OF OBSERVER: ..... SIGNATURE: .....

Appendix I: Mathematics content course outlines

MAT 340: INTRODUCTION TO REAL ANALYSIS

CONTENT

1. Sets and the Real line R

- Elements of algebra;
- relations as subsets of (X*Y) where X, YCR;
- Surjective and injective relations; functions as special relations; inverses of functions; direct and inverse images of a set under a function.
- Natural numbers; integers; rational and irrational numbers; the real number line R;
- R as a totally ordered field; the real numbers 0 and 1;
- |x| for x in R; Dedekind cuts on Q and R; Boundedness of subsets of R;
- The nested interval property, the axiom of Arcimedes and the denseness of rationals in R.

2. Sequences in R

- Sequences; bounded sequences; converging sequences;
- Cauchy sequences in R: liminf sup of sequences;
- diverging sequences monotone sequences: sub sequences:
- completeness of R.

3. Infinite Series

- Infinite series as a special case of sequences; convergence of infinite series;
- standard series (geometric and harmonic);
- Theory of positive series.
- Tests for convergence of infinite series infinite series (comparison tests, D' Alembert, Guass, Cauchy, integral test etc.).
- General real series. Absolute convergent series. Conditional convergence. Uniform convergence.
- Power series.
- Representation of standard elementary functions (e.g. (1+x), e, log (1+x), sin x) as infinite power series.

4. Continuity

- Limits of functions;
- Continuous real valued functions from subsets of R into R;
- some properties of continuous functions on closed intervals.

5. Aspects of Topology

- Open subsets of R, closed subsets of R,
- intervals, neighbourhoods, interior points, exterior points, boundary points, limit points of sets,
- Bolzano-Weistrass theorem, cantor intersection theorem, Lindelof covering theorem,
- compactness, the Heine-Borel theorem, compact sets, connected sets.

6. Continuous Functions & Those of Bounded Variation

- continuity at a point, continuity on a set, uniform continuity,
- preservation of connectedness under continuous mappings,
- intermediate value theorem, preservation of compactness (under continuous mappings), maximum and minimum value theorem, uniform convergence, step function approximation, functions of bounded variation.

7. Differentiable Functions

- Differentiability at a point, differentiability on a set, differentiability,
- continuity, theorems on differentiation, Rolle's theorem, improper integrals,
- mean value theorem, generalised mean value theorem (Taylor's theorem) and applications.

8. Riemann Integral

- Partition of an interval, refinements of a partition, Riemann sums, Riemann integral, integrability criterion of Riemann classes of integrable functions,
- properties of the Riemann integral, integral calculus,
- the first mean value theorem for integrals, the Riemann stieljes integral.

MAT 420: INTRODUCTION TO TOPOLOGY

CONTENT

1. **Metric Spaces**
   -Sets, open and closed sets, completeness, Baire category theorem; Euclidean spaces, Banach space, compactness, characterization of compact metric space, continuous functions, Normed linear spaces; linear operators, principle of uniform boundedness; contraction mapping principle.

2. **Point Set Topology**
   Topological spaces, subspaces, continuous functions; Base for a topology Separation Axioms, compactness, Locally compact spaces, path connectedness, finite product spaces, transfinite induction; infinite product spaces, Tychonoff's theo]

Appendix J: Mathematics Methodology-related course outlines

MAT 330: Fundamentals of teaching and Learning Mathematics

CONTENT

1. Teacher knowledge.
   - *Types of teacher knowledge*
   - *Ways of increasing teacher knowledge*

2. Assessment
   - *Types of assessment?*
   - *Points for and against assessment*
   - *Test validity & reliability,*
   - *Item/task analysis (difficulty index, facility index, discrimination index etc.)*
   - *Table of specification*
   - *Typing of tests and exams*

3. Scope and Sequencing instructions
   - *Vertical sequencing*
   - *Horizontal sequencing*
   - *Concept mapping.*

4. Pupils with special needs
   - *Mathematically gifted pupils*
   - *Slow learners*
   - *Impaired pupils*
   - *Mentally retarded*
   - *Girl child &boy child*
   - *Learning difficulties in Mathematics*

5. Ethno Mathematics
   - *Examples of Ethno Mathematics in Zambia context and elsewhere.*
   - *Values of Ethno mathematics*
   - *Challenges in integration of ethno Mathematics in Mathematics curriculum*

MAT 430: Theoretical and practical basis for Learning and Teaching Mathematics

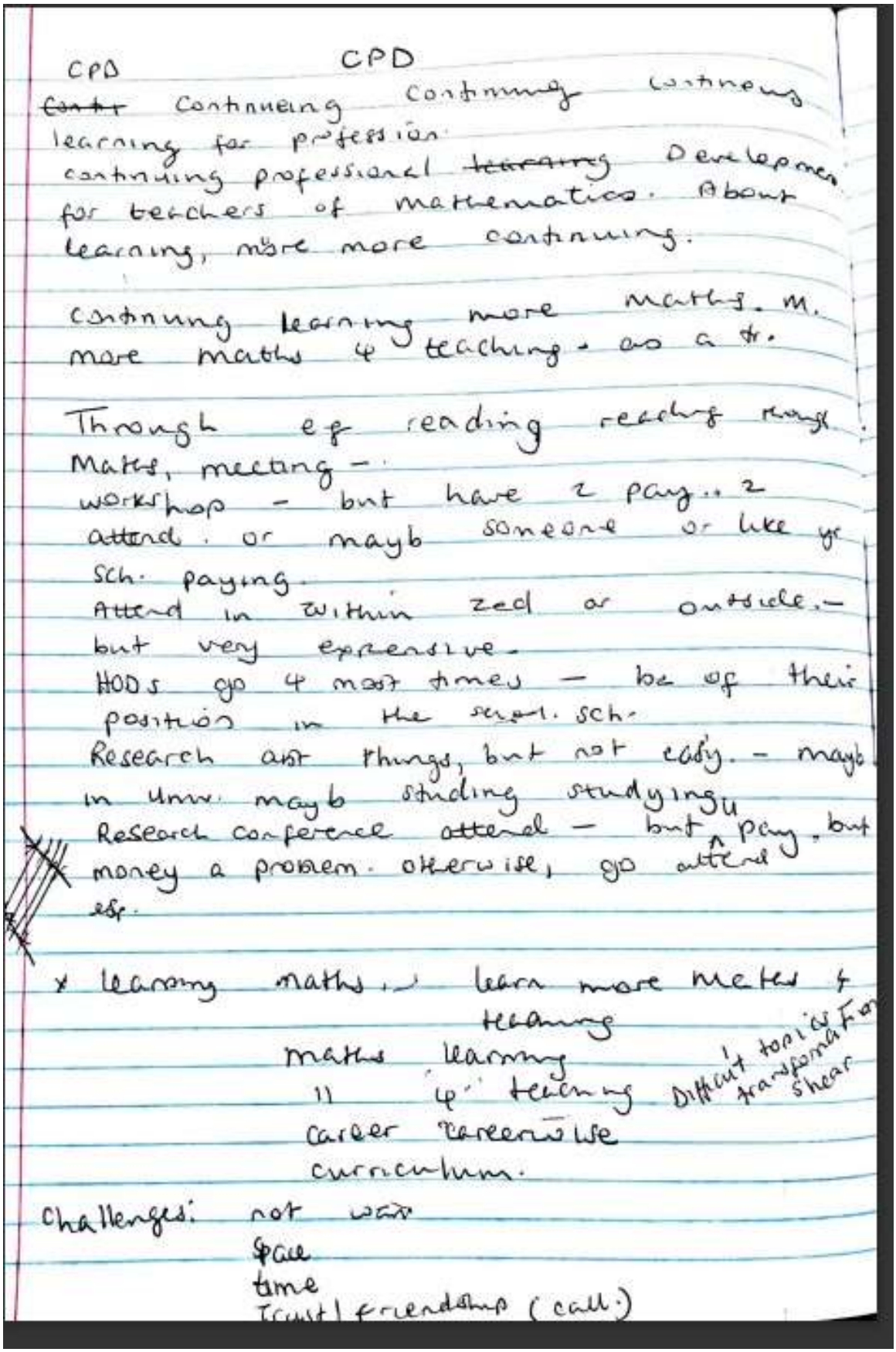
CONTENT

1. Research in mathematics education (internationally),
   - Types of research
   - Data collection instruments & techniques:
   - Questionnaires, interviewing (structured, semi-structured, unstructured), stages in interview,
   - Observations (participant observation, complete observation, etc.),
   - Document analysis,
   - Sampling procedures
   - Simple statistical charts: bar charts, histograms, pie charts, line graphs etc.,
   - Simple statistical calculations on measures of central tendency, dispersion etc.,
   - Analysis of qualitative data,
   - Outline of research proposal and report,
   - Action research,
   - Reading & critiquing research report papers in mathematics education.
2. The history of Mathematics
   - Historical details about the branches of Mathematics
3. Mathematics and Language
   - Mathematics as a language
   - The role of language in teaching Mathematics
   - Influence of English on the learning and teaching of Mathematics
   - Influence of the use of local languages on the learning and teaching of Mathematics
   - Multi-linguism
4. Gender issues in mathematics
   - Some reasons for poor girls' /boys performance
   - Strategies to boast girls'/boys performance
5. Curriculum and syllabus
   - Types of curricula
   - Features of a curriculum
   - Curriculum development process
   - Watered up curriculum
   - Watered down curriculum
   - Zambian mathematics teaching/examinations syllabuses
   - Components of "O" level Mathematics syllabus and additional Mathematics syllabus
   - Interpretation of the content of the syllabus
6. Mathematics performance issues in Zambian secondary schools
   - Including issues of high stakes examinations,
   - Teaching to the test
7. Technology in mathematics,
   - Technologies and teaching/learning of Mathematics
   - Computer assessments & challenges etc.
8. Current issues at the time in mathematics education (in Zambia & internationally),
   - Assessment practices in Mathematics
   - Mathematics Pedagogies & current beliefs

- Continuous professional development of teachers of mathematics,
- Professional associations
- Cross cutting issues

9. Selected topics from Additional Mathematics
    - Combinations and Permutation
    - Calculus

Appendix K: Sample of Students notes



Appendix L: Sample Test paper

MAT 330 TEST 3

Instructions:
-There are paper five (5) questions.
-Answer all the questions.
-Use examples to illustrate your answers.
-Marks for each question are indicated in the brackets [].

1. Pre-requisite Mathematical knowledge is one of the important points to consider when preparing a lesson.
   (i)With appropriate an example, discuss the meaning of 'Pre-requisite Mathematical knowledge'. **[4]**
   (ii)Explain **two (2)** negative effects of teacher ignoring Pre-requisite Mathematical knowledge when preparing a lesson. **[4]**

2. (i)Discuss **six (6)** ways through which a Mathematics Teacher's Mathematical knowledge can be enhanced. **[12]**
   (ii)Explain **three (3)** hindrances to increasing a Mathematics Teacher's Mathematical knowledge. **[6]**

3. Discuss **three (3)** ways in which school teaching experience helps a student teacher in the Teacher training process. **[6]**

4. Mathematics can be taught through error analysis.
   (i)Explain how mathematics can be taught through error analysis. **[1]**
   (ii)Discuss **two (2)** possible challenges that can be faced when teaching mathematics through error analysis. **[4]**
   (iii)Explain **two (2)** possible errors that a Grade 10 learner can make when factorising $4x^2 - y^2$ **[2]**
   (iv) Discuss **one (1)** possible cause of one of the errors identified in (ii) above.**[2]**

5. With appropriate examples, explain why it is important during a Mathematics lesson for a teacher to:
   (i) Think about the way s/he is teaching **[3]**
   (ii) Listen to what learners are saying **[3]**
   (iii) Talk to individual learners **[3]**

The end

MAT 430 TEST 2

Instructions:
-Answer all the questions.
-Use examples to illustrate your answers.
-Marks for each question are indicated in the brackets [ ].

1. a. Discuss **three (3)** home-based factors and **three (3)** classroom-based factors which can contribute to the underachievement of girls in Mathematics. **[12]**
   b. Discuss the measures you would put in place to overcome **each** of the barriers identified in 'a' above. **[6]**

2. Provide a fully worked solution to the question below.
   A Curve is such that $\frac{dy}{dx} = 4x^2 - 9$. The curve passes through the point (3, 1)
   a. Find the equation of the curve. **[4]**

   b. State, with reasons, state **two (2)** pre-requisite Mathematical knowledge needed for solving the problem in 'a' above. **[4]**

   c. Outline any **two (2)** difficult you think secondary school pupils are likely to encounter in solving the problem in A above and explain how you would help them overcome the identified difficult. **[4]**

3. a. Professional Associations are considered as one of the means for Continuing Professional Development (CPD). Discuss **five (5)** ways in which Professional Associations can contribute to a Mathematics teacher's CPD. **[10]**
   b. Discuss **five (5)** factors that can consciously or unconsciously constrain a mathematics teacher's professional development. **[10]**

The end

Appendix M: Proposed Budget

PROPOSED BUDGET

S/N	DESCRIPTION	COST
1	2 Reams of Paper	K300
2	Transport to and from Lusaka x2(Submission of ethical clearance application and final dissertation)	K1000
3	Data Bundles/Talktime	K600
4	Printing, Photocopying and binding of documents for ethical approval 4 copies of Full Protocol 9 Summary of Protocol 4 Questionnaire and/or interview schedules 4 Information Sheet 4 Consent Form 4 Budget 4 Time Line Clearance fee	K1300
5	Printing, photocopying and Binding of dissertation (5 copies)	K2000
6	Contingency	K800
7	**TOTAL**	**K6000**

Appendix N: Work Plan

WORK PLAN

S/N	ACTIVITY	WHEN
1	Reading and consultations with supervisor on research area/idea	March to June 2022
2	Proposal chapter writing and submission to supervisor	July 2022 to February 2023
3	Draft proposal submission	March 2023
4	Working on comments on the draft proposal from the supervisor	April 2023
5	Proposal presentation to the Department	May 2023
6	Working on comments on proposal from presentation to the Departmental	June 2023
7	Ethical clearance	July 2023
8	Data collection and analysis	August to September 2023
9	Report writing and submission of draft to the supervisor	October 2023
10	Making corrections on the draft report and resubmission to the supervisor	November 2023
11	Submission of Dissertation for examination	December 2023
12	Pre-defense at Departmental level Final defense, simultaneous making of corrections and submission	January-February 2024